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IRON AND STEEL ENGINEER

JANUARY • 1939

VOL. XVI NO. I

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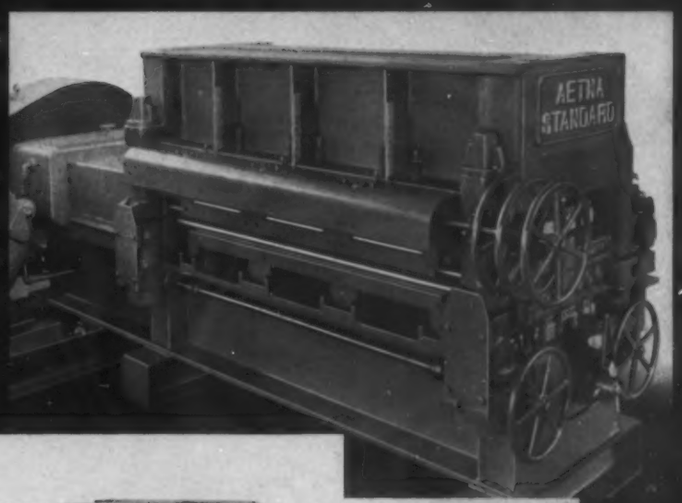

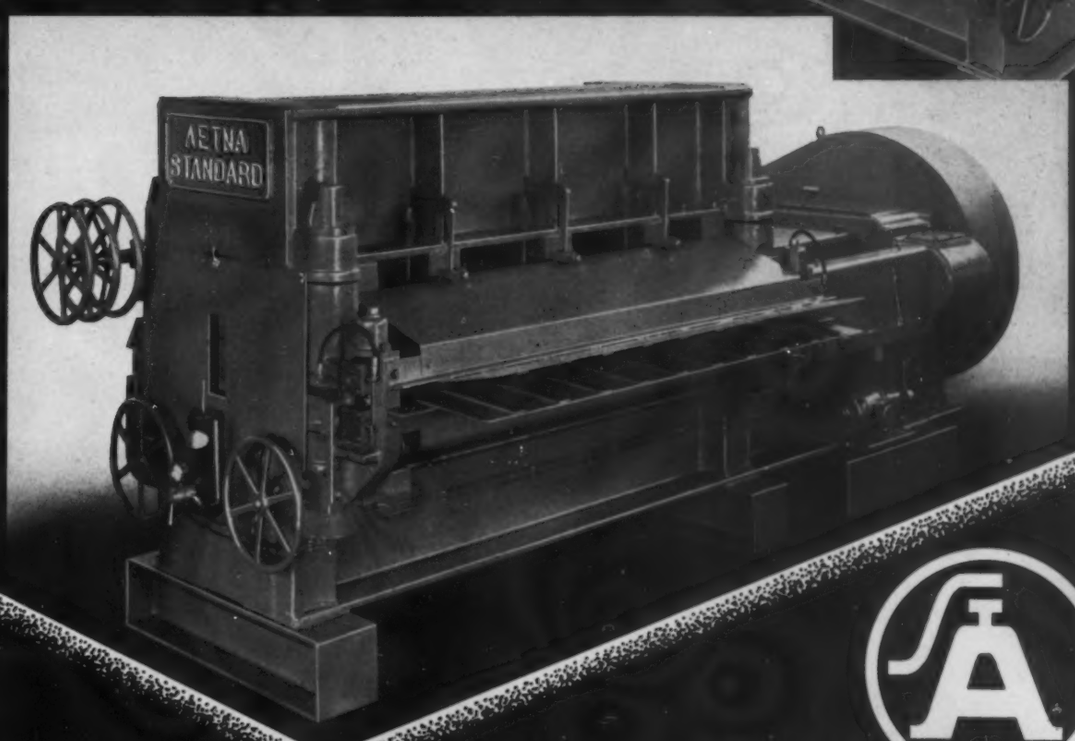

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THE PRESIDENT'S MESSAGE

It is with the deepest sense of responsibility that I assume the honor and office of President of the Association of Iron and Steel Engineers.

That those who have preceded in this office have served well is abundantly evident. One need only glance at the record or consider the place which our Association has won in the iron and steel industry through their tireless efforts.

At each year's end, as we turn the pages of our Association proceedings with ever increasing pride, we are thankful indeed that our lot has been cast in a progressive industry during a progressive age. We are filled with that enthusiasm which, while regarding with a fair degree of satisfaction the accomplishment of the past, looks forward eagerly and with greater confidence than ever to a future rich in opportunity.

To the members of our Association on behalf of its officers, directors and staff, may I express the hope that we shall amply justify your confidence in the year to come.

C. Clarke Wales

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Association of

Iron & Steel Engineers

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Director

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Director

NEWLY ELECTED OFFICERS AND DIRECTORS

Julius A. Clauss started his steel mill career with the Lackawanna Steel Company, which company he was with for seven years. He then went with Corrigan-McKinney Steel Company for two and one-half years as chief designer and checker. Following this he was the chief draftsman for the William Tod Company at Youngstown, Ohio. Leaving this company he went with the Republic Iron and Steel Company as assistant chief draftsman for twelve years. The next three and one-half years he served as chief engineer for the Trumbull Steel Company, and from March 1929 he has been with the Great Lakes Steel Corporation, at Ecorse, Michigan, as chief engineer.

William A. Perry started with the Inland Steel Company twenty-eight years ago, and successively held the positions of mill motor foreman, assistant superintendent of power stations, and assistant electrical superintendent. He was advanced to his present position as superintendent of the electrical and power departments with the company in January 1931.

Martin J. Conway was educated in mechanical and chemical engineering at Hanley and Oxford Universities, England. From 1920 to 1923 he was fuel engineer for Pittsburgh Crucible Steel Company, Midland, Pennsylvania, and held a similar position at the Steubenville, Ohio, plant of the Wheeling Steel Corporation from 1923 to 1926. For the past thirteen years he has been associated with the Lukens Steel Company, Coatesville, Pennsylvania, as fuel engineer.

Frank Edward Flynn started in the steel business with the Superior Steel Company at Carnegie, progressing from the position of water boy to that of boss roller. In 1916, he started in charge of rolling at the Phillips Sheet and Tin Plate Company, which later became the Weirton Steel Company, and during his 11 years service there he became assistant manager and then manager. He went to the Trumbull Steel Company in 1928, as assistant vice president in charge of operations. This company later became a unit of Republic Steel Corporation, and he was made assistant district manager. When the general offices of Republic Steel Corporation were moved to Cleveland, he became general superintendent in charge of all operations at the Warren Division, which is composed of the Warren, Niles, Trumbull Cliffs and Newton Falls Works. In April 1937 he was appointed as general manager of the Warren-Niles district.

J. Ledlie Miller has been employed in the steel industry since 1909, serving as messenger, draftsman, and in the experimental engineering department of Carnegie Steel until he joined the Army, where he served over seas as lieutenant in the heavy field artillery. Serving as fuel engineer at the Bellaire works of Carnegie from March 1919 until the steel strike that fall, he returned to the Carnegie Institute of Technology where he received his degree in mechanical engineering the following year.

Mr. Miller returned to Bellaire as fuel engineer and when this plant was closed, went to the Follansbee Brothers plant in Toronto, where he was annealing department foreman and assistant metallurgist until January 1, 1925. He served as fuel engineer of the Wheeling Steel Corporation in the Wheeling district from 1925 until he went to Youngstown for Carnegie in 1928. He acted as assistant chief engineer of Carnegie-Illinois Steel Corporation in the Youngstown district from 1928 to 1936. In 1937 he was appointed assistant chief combustion engineer of Republic Steel Corporation with headquarters in Cleveland.

Thomas E. Hughes, superintendent of maintenance department, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania, has spent his entire business background in the steel industry. Mr. Hughes started to work with the Union Railroad in 1902, and successively worked at the Clairton Plant of the Carnegie-Illinois Steel Corporation, McKeesport Plant of the National Tube Company, Youngstown Plant of the Youngstown Sheet and Tube Company, and for the past twenty-six years has been at the Duquesne Plant of the Carnegie-Illinois Steel Corporation. Mr. Hughes attended the public schools of Duquesne, and the night classes of the Carnegie Institute of Technology.

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R. R. THOMAS
Director

R. R. Thomas is the assistant chief engineer, blast furnaces and steel works, Tennessee Coal, Iron and Railroad Company, Birmingham, Alabama. Mr. Thomas began his career with the United States Steel Corporation subsidiary in 1907 as a blueprint boy at the Ensley Works. He became chief draftsman of the open hearth division in 1926 and was made assistant chief engineer of blast furnaces and steel works in 1929.

George O. Van Artsdalen, superintendent of maintenance department, Henry Disston and Sons, Inc., Philadelphia, Pennsylvania, was educated in the Philadelphia public schools and extension schools.

From 1912 to 1917 he was affiliated with electrical contracting and maintenance work in the Philadelphia area. During the World War, he was a chief electrician in the United States Navy. Following the conclusion of the war, and during the year of 1919, he was supervisor of electrical wiring and installation, William Cramp Sons Ship and Engine Building Company. Since 1919, Mr. Van Artsdalen has been with Henry Disston and Sons, Inc., first as chief electrician, from 1930 to 1936, and since that time superintendent of the maintenance department.

H. W. Neblett, development and new design engineer, Inland Steel Company, Indiana Harbor, Indiana, has been particularly concerned with power plant work and the development of new steel mill equipment.

Mr. Neblett's steel mill experience began with the Mark Manufacturing Company at Indiana Harbor, Indiana, in 1916. Later the name was changed to the Steel and Tube Company of America, the plant now being owned by the Youngstown Sheet and Tube Company. He was located with this plant from 1916 to 1920, as assistant electrical engineer, and from 1920 to 1922 he was electrical engineer at the Chicago office of the Steel and Tube Company of America. From 1922 to 1928 he was with the Colorado Fuel and Iron Company as engineer in charge of electrification of steel plants including power plants, the electrification of the existing mills and new mills that were constructed during that period. From 1928 to 1932 he was head of the Neblett Engineering Company in Chicago, a consulting engineering corporation dealing with the design and installation of steel mill equipment. In 1932 he went with the Inland Steel Company, Indiana Harbor, Indiana, and assumed the duties which lead to the position he now holds.

Clinton Curler Pecu, has been with the Bethlehem Steel Company for thirty-six years, and has held his present position as lubrication engineer for twenty-nine years. Prior to his connection with this company he served for fourteen years as foreman of the spring department, Haviland Shade Roller Company, Vergennes, Vermont. He is now located at the Lackawanna plant of the Bethlehem Steel Company.

C. L. McGranahan's first work in the steel industry was in 1916 with American Sheet and Tin Plate Company. He worked in various positions with the company at their different plants until 1931, allowing for one year World War Service. In 1931 he joined the Inland Steel Company as superintendent of the company's Indiana Harbor hot strip mill, resigning in February 1936, to take his present position as assistant general superintendent with the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Mr. McGranahan was graduated from Pennsylvania State College in 1916 with a bachelor of science degree in civil engineering.

James G. West, Jr., is superintendent of blast furnaces and coke ovens, for the Chicago district of the Youngstown Sheet and Tube Company, East Chicago, Indiana. Mr. West received his technical education at Georgia School of Technology, Atlanta, Georgia. He started in the steel business in 1903, and worked successively at the following plants: National Furnaces, National Tube Company, McKeesport, Pennsylvania; Carnegie Steel Company, Donora, Pennsylvania; Carnegie Steel Company, Edgar Thomson Works, Braddock, Pennsylvania; Illinois Steel Corporation, South Chicago Works, Chicago, Illinois; and Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. After doing consulting engineering work, Mr. West then went with the Youngstown Sheet and Tube Company.

J. S. Murray, chief electrical engineer, Follansbee Brothers Company, Follansbee, West Virginia, was educated in the Toronto, Ohio, public schools, Carnegie Institute of Technology, and the students course at Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania. Mr. Murray entered the employ of Westinghouse in 1916, in the research and sales department. He entered consulting engineering work at Pittsburgh in 1918. In 1920 he went with the Follansbee Brothers Company, where he holds the title of chief electrical engineer. He has supervised the production, test and application of silicon steel sheets produced by the Follansbee Brothers Company since 1932.

Thomas J. Flaherty, electrical superintendent, American Rolling Mill Company, Ashland, Kentucky, started to work in 1900 as a helper in the electrical department of the La Belle plant of what is now the Wheeling Steel Corporation, Steubenville, Ohio. Mr. Flaherty worked as motor inspector for the Colorado Fuel and Iron Company, Pueblo, Colorado, in 1904 and 1905. In 1905 he returned to the La Belle plant where he worked as electrical foreman until 1910. In 1910 he went with the American Rolling Mill Company, Middletown, Ohio as electrical foreman. He left Armco in 1913, going to the Cambria plant, Bethlehem Steel Company, Johnstown, Pennsylvania, where he became general foreman in the electrical department. Mr. Flaherty joined the American Rolling Mill Company again in 1923 going to the Ashland, Kentucky, plant as assistant electrical superintendent. He was made electrical superintendent in 1925, holding that position until the present time.

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1933 J. D. DONOVAN, Electrical and Mechanical Superintendent, Republic Steel Corporation, Massillon, Ohio.
1935 W. H. BURR, Electrical Superintendent, Lukens Steel Company, Coatesville, Pennsylvania.
1936 G. R. CARROLL, Assistant Superintendent of Maintenance, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania.
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C. C. Pecu, Lubrication Engineer, Bethlehem Steel Company, Lackawanna, New York.

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G. A. Hughes, Elec. Engineer, Truscon Steel Company, Youngstown, Ohio.

T. E. Hughes, Supt., Maintenance, Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania.

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W. A. Perry, Superintendent, Electrical and Power Departments, Inland Steel Company, East Chicago, Indiana.

ANNUAL *Spring* CONFERENCE

BIRMINGHAM, ALA. MARCH 27-28, 1939

TENTATIVE PROGRAM

"Unique Features in Southern Blast Furnace Practice"

"Modern Wire Drawing Practice"

"General Types of Lubricants Essential to the Steel Plant"

"Modern Soaking Pits"

These papers will be presented at two technical sessions to be held Monday morning and evening.

INSPECTION TRIPS

Inspection trip to the American Cast Iron Pipe Company on Monday afternoon.

On Tuesday the entire day will be devoted to an extensive inspection trip through the Tennessee Coal, Iron and Railroad Company properties in the district.

Optional trips may be made to other plants in the Birmingham district by those interested in a more extensive stay.

HEADQUARTERS - HOTEL TUTWILER

Design of Modern SLABBING - BLOOMING *Mills*

By LORENZ IVERSEN, President

MESTA MACHINE COMPANY

PITTSBURGH, PENNA.

Presented before the A. I. & S. E. Annual Convention, Cleveland, O. September 27, 28, 29, 30, 1938

▲ I WAS asked to talk about the design of modern blooming mills, but have taken the liberty of broadening this subject to include the design of modern slabbing and blooming mills, for reasons which will become obvious as I proceed. To me this is an interesting subject, since it embraces the first step in the process of rolling steel into the various forms that make it such important commodity.

The designation, as well as the design, of any equipment must naturally be governed by the work it is intended to perform, and we should begin by defining the word "blooming" as used when referring to the rolling of blooms. In the language used in steel works it is quite general to designate the mills which roll ingots coming from soaking pits as blooming mills, no matter whether such ingots are rolled into blooms or any other sections. An exception to this is in the case of the universal slabbing mill. That I have been asked to read a paper on the design of modern blooming mills, when the mills I am really expected to talk about do not produce blooms at all, indicates how general the use of the term "blooming" has become. Perhaps "roughing" would be a better term, though not definite, since there are many types of roughing mills. "Slabbing" alone is not suitable either, because the universal slabbing mill is frequently referred to as just "slabbing" mill. In view of these considerations I have decided that the modern mill which constitutes the basis of my paper should be christened "slabbing-blooming mill". This particular type of mill has been developed principally to meet the demand of modern strip mills for

FIGURE 1—Shop view of the 45″ x 80″ universal reversing slabbing mill for Edgar Thomson Works, Carnegie-Illinois Steel Corporation.

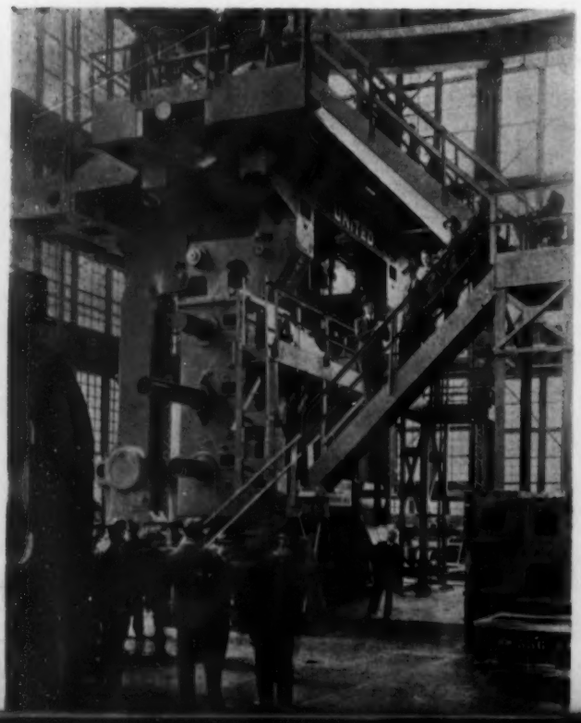
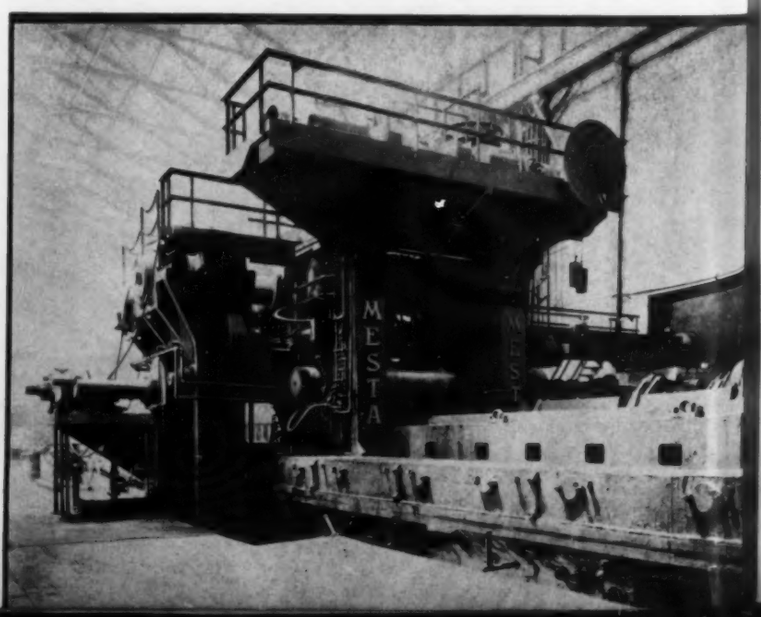


FIGURE 2—44″ x 96″ universal slabbing mill installed at South Works of Carnegie-Illinois Steel Corporation.



LORENZ IVERSEN

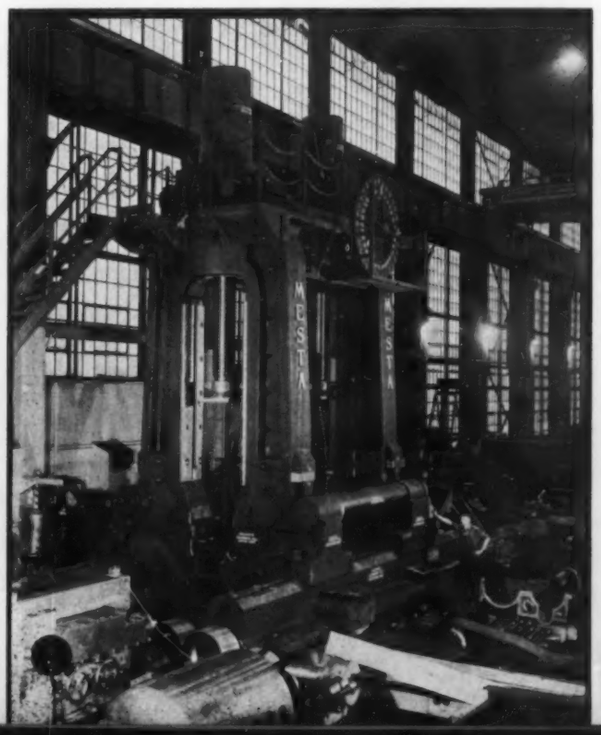
suitable wide slabs, and when asked to read a paper on modern blooming mill design, I assumed it was intended for me to talk about this type of mill.

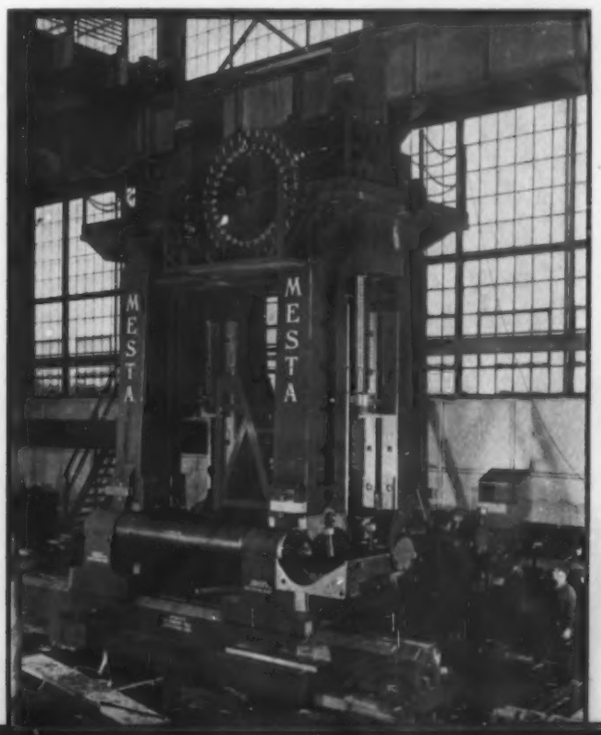
Need for development of the slabbing-blooming mill was brought about by the change which has taken place within the last ten years in the method of producing flat rolled products. During this period the demand for flat products has also increased in greater ratio than for other sections. Previously, slabs were produced for use as heavy flat sections or for rolling into plates, while the majority of other flat products were made from sheet bar. Slabs of the larger sizes were rolled directly from ingots by universal slabbing mills, and sheet bars were produced from blooms. In those times, the quantity of large slabs required in the nation was small as compared to the total tonnage of flat products rolled and so the number of universal slabbing mills required to produce large slabs was not great. The regular two-high blooming mills were capable of producing the narrower sizes of slabs. This picture has now changed completely.

If we go through the history of continuous four-high strip mills from the time they commenced to assume a really important role in the industry—I am thinking of the American Rolling Mill Company's mill at Butler and of the Republic mill at Warren—we see that these earlier mills were capable of efficiently rolling strip up to widths of about 36 inches, for which widths slabs could be produced on existing blooming mills. Later came the 48 inch strip mill at Weirton, and then another strip mill at Middletown, Ohio. The blooming mill intended to produce slabs for the Weirton strip mill was of a comparatively modern type which could be provided with new housings and thus made capable of rolling 48-inch slabs. In the case of the blooming mill at Middletown no changes of which I know were made and wide strips are produced on their strip mill by cross rolling the slabs. However, extensive changes are now being made.

The importance of the cold rolling process became gradually known and later the advantage of having long coils for such rolling became evident. At the same time the demand for wider cold rolled sheets also became urgent. In consequence, the next hot strip mill built was made 60 inches wide, and was installed at the Wheeling Steel Corporation's Steubenville plant. At this plant a 45-inch blooming mill on hand was not

FIGURES 3 and 4—Shop views of a slabbing-blooming mill, showing accessibility and simplicity of construction.





capable of producing slabs suitable for such a strip mill. In fact, this blooming mill could not produce slabs over 42 inches wide and it was therefore decided to convert it into a universal slabbing mill capable of making slabs up to 60 inches wide. At that time nobody thought seriously of anything but a universal slabbing mill to produce large slabs.

The opinion that a universal mill was needed to make slabs seems to have prevailed for a considerable time. This is borne out by the fact that the next large mill intended for slabbing work, installed at the South Works of the then Illinois Steel Company, was also of the universal type, and that all plans for the Great Lakes Steel Corporation, as well as for the Inland Steel Company—and probably for other mills—contemplated the future installation of universal slabbing mills.

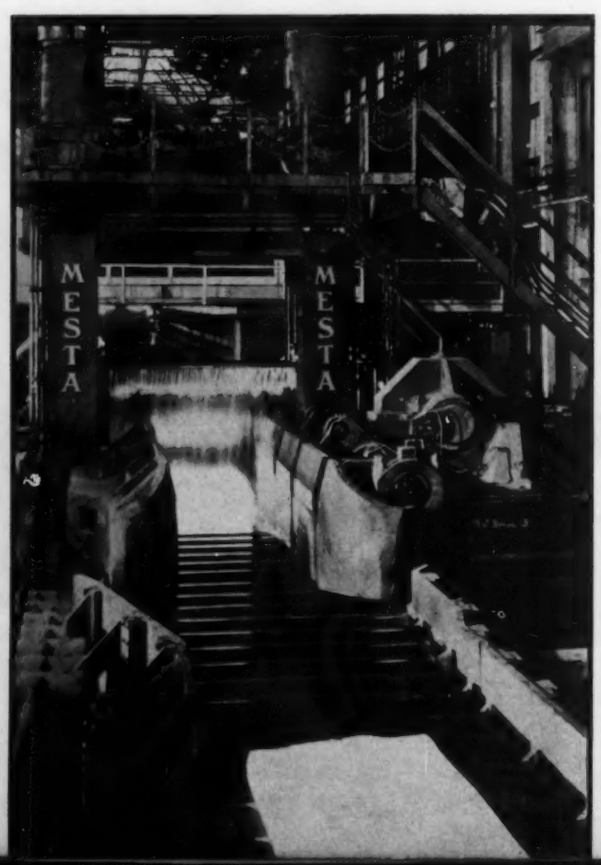
When Inland inquired for a slabbing mill, doubt arose in my mind as to whether a universal mill was the right kind for them. It is true that a universal mill can produce nice slabs, but such a mill has many disadvantages when considering the plant as a whole. The greatest disadvantage of the conventional universal slabbing mill has been the inability of such mills to do sufficient edging work on heavy ingots. There were continual complaints about all previous mills of this type because insufficient power was available for driving the vertical rolls, even though the power had been increased to the maximum we felt could be transmitted through the types of drives which could be used on the vertical rolls. On ingots of 24 inches or more in thickness the small diameter vertical rolls of the conventional universal mill cannot take much of a "bite", even if the power required to drive them is available, with the result that where a variety of slab widths are needed the steel plant is required to make numerous sizes of ingots having variations in widths of as little as 4 to 6 inches.

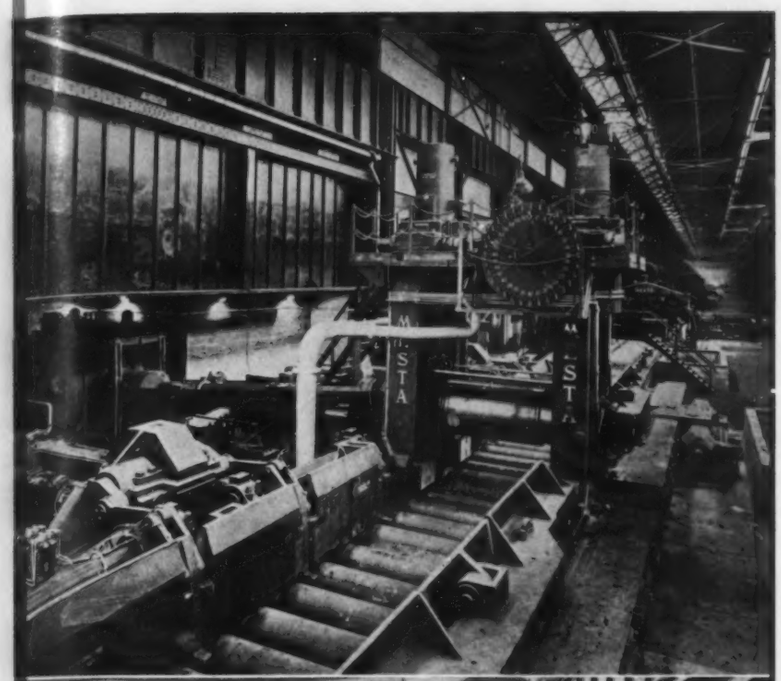
This analysis led me to recommend to the Inland Steel Company the installation of a two-high reversing mill, without vertical rolls, designed especially for the production of large quantities of wide slabs. With such a mill, where the ingot is turned for edging on the horizontal rolls, it can be seen that as much edging work can be done as desired, and therefore a slab ingot can be reduced to any slab width desired, thus eliminating the need for a large number of ingot widths. The advantage of having such a mill is evident, and it did not take Inland long to figure what it meant to their steel making plant if only two or three mold sizes were needed as compared to the six or more required to produce all of the necessary slab widths with the conventional type of universal-slabbing mill.

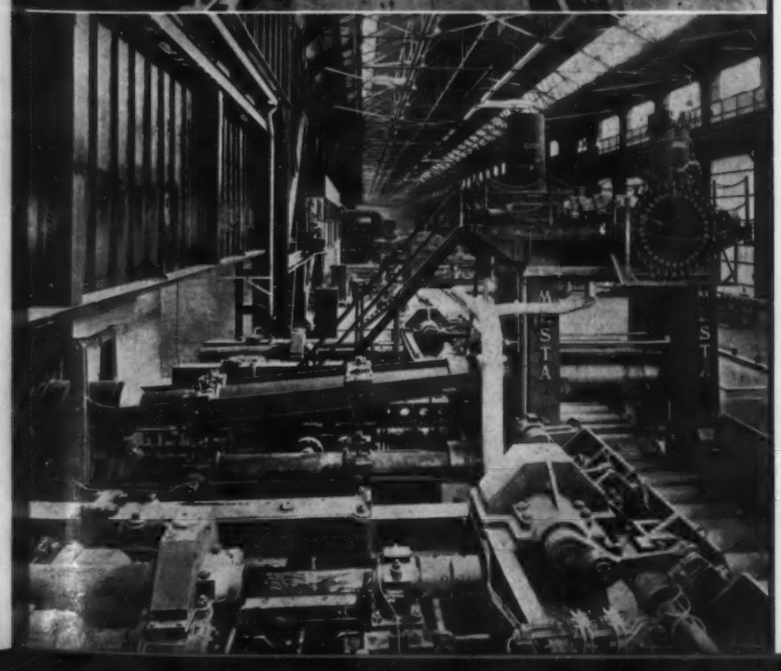
Most of the mills installed recently have been of the two-high reversing type without edging rolls. They are really more slabbing than blooming mills, since slabs are the principal product rolled, although they have been designed to produce blooms also, and their capacity for this product has not been impaired in the least. Rather, the capacity for producing blooms has been increased because of the increase in speeds of screwdowns. An exception to this is a universal type mill as illustrated by Figure 1, which shows a shop view of the 45″ x 80″ universal reversing slabbing mill built for the Edgar-Thomson Works of the Carnegie-Illinois Steel Corporation. The horizontal rolls are independently driven by a 5000 hp. reversing motor for each roll, and in this respect the mill is similar to the one installed at the South Works of the Carnegie-Illinois Steel Corporation, in which the rolls are also driven independently, without pinions, by two 5000 hp. motors. This type

FIGURE 5—Entry side of modern slabbing-blooming mill, showing massive side guards used with the manipulator.

FIGURE 6—Delivery side of slabbing-blooming mill, showing the manipulator finger mechanism.







of drive has performed very satisfactorily during the seven years it has been in operation. Figure 2 is a view of the mill installed at South Works. The vertical rolls of this mill are driven by a 3000 hp. motor through bevel gears. The horizontal rolls have a maximum opening of 44 inches.

The Edgar-Thomson mill has a lift of 66 inches and is capable of reducing the width of large ingots to any slab width desired on the horizontal rolls. The vertical rolls are, of course, available to maintain slab widths after the ingot has been reduced to a desired width. The vertical roll mounting and drive of this latest universal slabbing mill is of interest. The vertical rolls are 36 inches in diameter and are driven by a 3000 hp. reversing motor through a combination of bevel and helical gears enclosed in separate oil tight gear cases, with all shafts mounted in roller bearings. The vertical rolls are connected to the drives by spindles and can be removed from the front of the mill without requiring the removal of any of the drive gears or shafts. Another interesting feature is that the rolls can be turned end for end, thus giving double life, since only the lower end of the roll is in use when rolling. This mill, I understand, can handle ingots weighing up to 45,000 pounds and produce slabs 8″ x 60″ x 20′ long. It is evident

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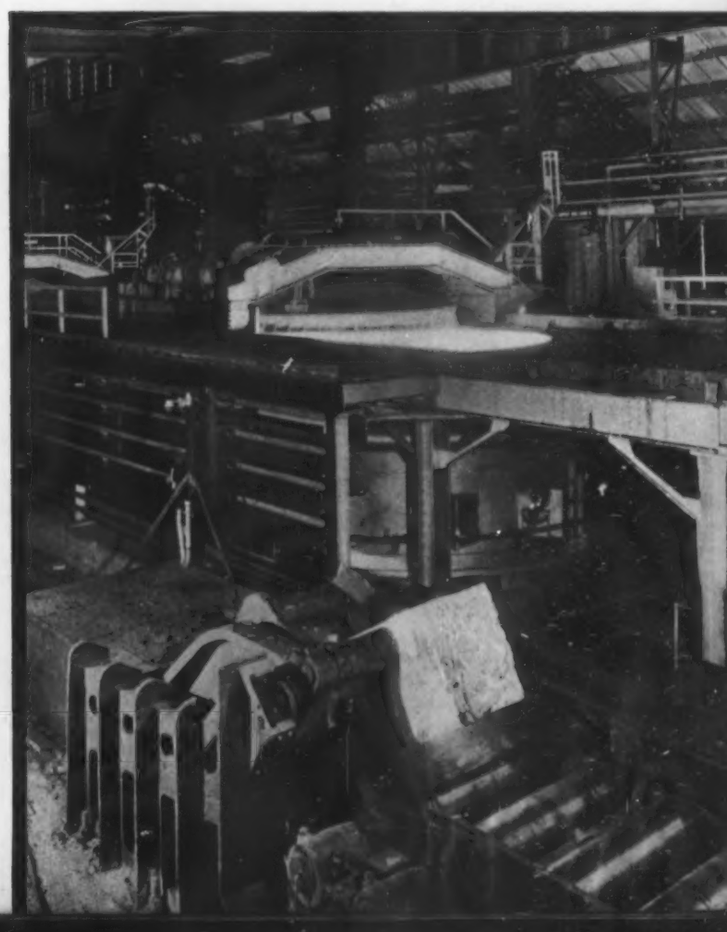
FIGURE 7—General view of slabbing-blooming mill from entry side, showing tables and manipulators.

FIGURE 8—This view of the delivery side of the mill shows the manipulator on the right, and the conveniently located scale pits to the left.

FIGURE 9—Long universal spindles are used on account of the high roll lift. Good visibility through the mill is an advantage to the operator.

FIGURE 10—An ingot buggy usually brings ingots to the mill approach table. In the background can be seen a modern design of soaking pit.



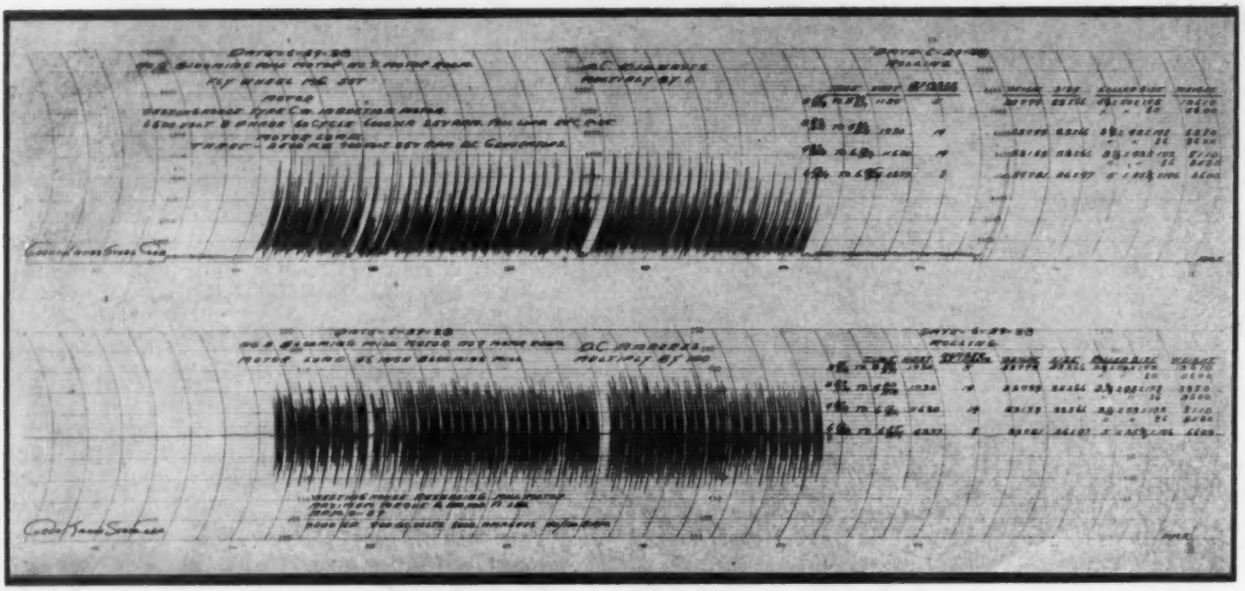


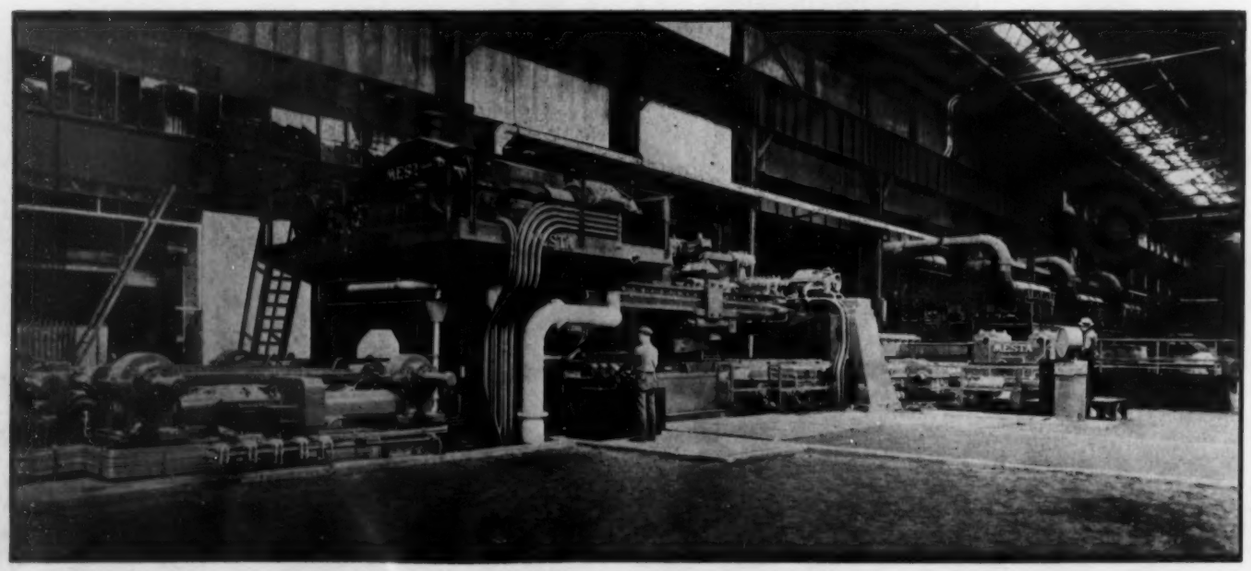
FIGURE 11—Charts from the main motor-generator set and drive motor of a slabbing-blooming mill, showing power required for rolling.

that such a mill has an enormous productive capacity. On the other hand, such a mill is expensive. I do not consider it to be as convenient as the slabbing-blooming mill when also required to roll blooms. Nevertheless, such an installation may be justified in plants where very large tonnage outputs of slabs only are required.

This mill effectively overcomes the disadvantages of requiring a large number of mold sizes, to which I have previously referred, since it can edge wide ingots on the horizontal rolls to any desired slab width in the same manner as the slabbing-blooming mill. The few general remarks I have made in reference to this latest and very interesting type of universal slabbing mill should be of interest, in view of the fact that I have made reference to slabbing mills, and since the subject of my paper is "slabbing-blooming mills".

To be specific in describing the slabbing-blooming mill I will cite as examples the new mills recently installed by the Inland Steel Company, the National Steel Corporation at Great Lakes and the Tennessee Coal, Iron and Railroad Company at its Ensley, Alabama plant. Figures 3 and 4 show a slabbing-blooming mill on the erecting floor. This mill is simple in construction and is quite accessible. Its installation represents a smaller initial investment than does the universal type slabbing mill and the mill is equally well adapted for making slabs of any desired width or blooms.

FIGURE 12—General view of bloom and slab shear designed to cut slabs 64″ wide by 6″ thick.



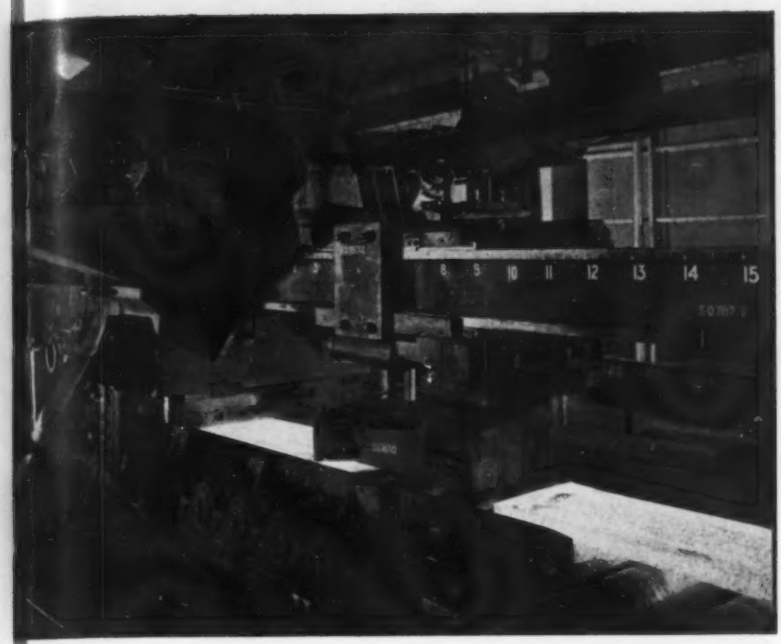


FIGURE 13—Screw-type motor driven shear gauge of heavy construction, designed for a maximum sheared length of about 21 feet.

Two such mills now in operation produce slabs at Inland up to 54″ wide and at Great Lakes up to 62″, and have a capacity of 300 tons per hour or even more when producing large slabs. The quality of slab produced is quite satisfactory for re-rolling on the modern type of strip mill.

FIGURE 14—Slabs, cut to desired lengths, are moved from the shear table to a transfer by means of a pusher.

The slabbing-blooming mill is generally supplied with ingots from the soaking pits by means of an electrically operated ingot buggy. In some cases the operator rides on the buggy; in others this ingot buggy is operated from the pulpit or by remote control from the cab of the soaking pit crane.

NEW MILLS HANDLE LARGE INGOTS

The largest ingots used at Great Lakes are 25″ x 66″ and are deposited on the mill approach table at a distance of approximately 75 feet from the mill. The Great Lakes mill can roll slabs 62″ or even 64″ wide. Taking this mill as a typical example we find that it has rolls which are 43″ diameter x 100″ long body with necks 27″ diameter x 29″ long, and bronze and babbitt bearings. The top roll is weight balanced and has a maximum lift of 66¼″. To prevent extreme wear on the screws and nuts due to the speed and travel necessary, special chrome-nickel-molybdenum screws are used together with bronze nuts. The screws are driven by two motors, each motor driving both screws through a double worm arrangement. A special oil circulating system is provided for screwdown lubrication.

In this particular mill the spindles between the mill and pinion stand are 27 ft. long between joints and have a motor-operated shifter. The pinions are cast steel, 46″ pitch diameter by 65″ face, and have double helical cut teeth. The pinion bearings are babbitted. An independent recirculating system for lubricating the pinion stand is designed to provide forced lubrication of the pinion bearings; also to spray the pinion teeth. The pinion housing holds about 150 gallons of lubricant, which is not sufficient to properly protect the pinions, and therefore a reservoir tank with a capacity of 700 gallons is provided. To circulate this lubricant two 25-gallon per minute rotary pumps are used. One of the pumps is in the return line from the pinion housing and pumps to the tank, while the other delivers from the tank t the bearings and spray nozzles.

ELECTRICAL EQUIPMENT

The mill is driven by a 7000 hp., 40 to 100 rpm., reversible, 600 volt, d-c. motor rated at two and a half million foot pounds maximum torque from 0 to 37 rpm. Figure 11 is a reproduction of charts taken from the main motor-generator set and motor driving the Great Lakes slabbing-blooming mill and shows the power required for rolling. The various sizes of slabs rolled are indicated. Some idea of the size of this motor is obtained when we learn that the armature weighs 94 tons.

Power for the mill is furnished from a 10,000 kva., 6600 volt, 3 phase, 60 cycle a-c. circuit. A 7500 kv. motor generator set supplies power for the main drive motor. This set consists of three 2500 kw., 600 volt, d-c. generators, and one 6000 hp., 352 rpm. 6600 volt, 3 phase, 60 cycle, wound rotor induction motor, equipped with a 15 ft. diameter by 20 inch face flywheel weighing 140,000 pounds. Two 755 kw. motor generator sets supply power for the variable voltage aux-

iliary motors. Each of these sets consists of one 800 hp. a-c. line starting motor, one 250 kw., 250 volt d-c. generator and three 135 kw. 250 volt d-c. generators. It is interesting to note that there are 61 auxiliary drive motors used in the entire installation, totalling 4,385 hp. and ranging in size from ¼ to 275 hp.

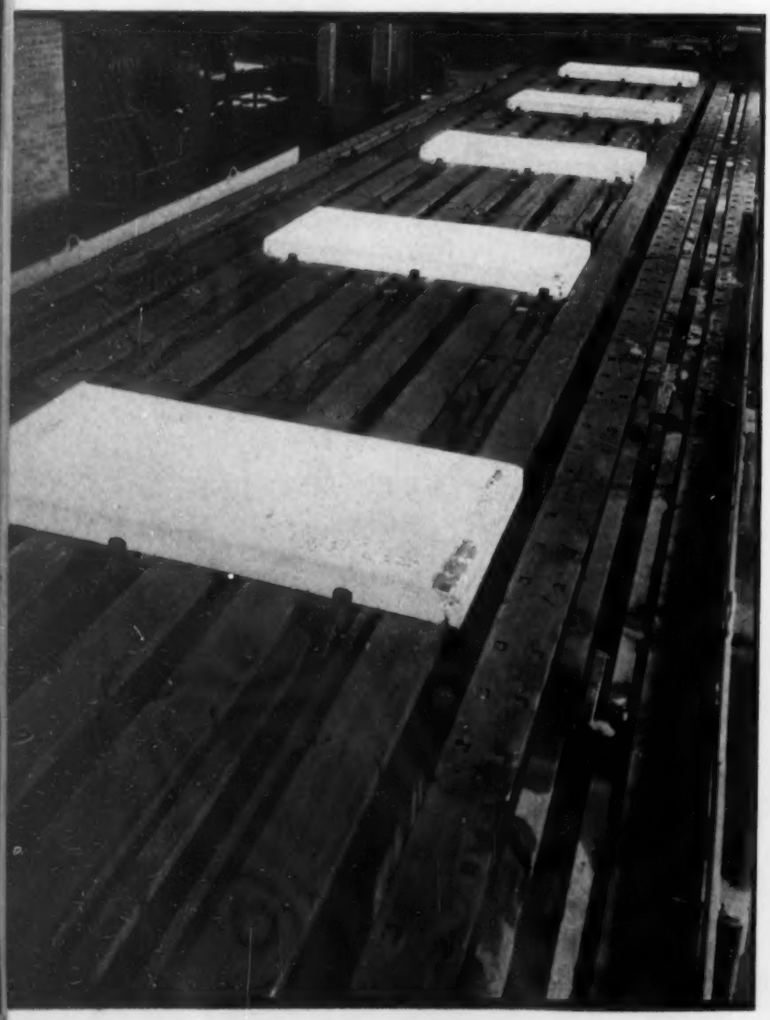
In previous installations of blooming mills, the auxiliary motors have been of the constant voltage, or rheostatic controlled type, whereas in more recent slabbing-blooming mill installations the most important auxiliary drives are operated by variable voltage motors. In this particular case variable voltage is used for controlling motors driving the screwdown, the front and rear mill tables, the manipulator and the slab shear.

AUXILIARIES OF HEAVY CONSTRUCTION

In a mill of this type, where heavy ingots are turned by the manipulator, the mill tables must be of extremely rugged design. Careful consideration has been given to the problems of expansion and distortion resulting from the combination of stresses due to heat and mechanical loading. The tables have solid forged rollers of generous size and all moving parts are mounted in anti-friction bearings. All gears are case-hardened and totally enclosed to exclude foreign matter.

The manipulator is of substantial and rugged construction and is electrically operated. Moving guards are provided on both sides of the mill to guide wide slabs for the edging passes. In addition, there are fingers on both sides of the mill. This eliminates dummy passes since slabs require one edging pass only for each of the final edging passes.

FIGURE 15—A transfer approximately 100 feet long by 16 feet wide conveys slabs into the slab yard.



SLAB SHEAR

The slab shear is located approximately 115 ft. from the centerline of the mill. Figure 12 shows a general view of the shear and gauge. The shear is designed to cut slabs 64″ wide by 6″ thick and is of the start and stop type without a clutch. It is a very compact, self-contained unit, leaving the floor free and unobstructed on both sides. Due to the compactness of this design there is a concentration of heat at some points and we have provided water cooling for all such points. The depressing table located at the delivery side of the shear is designed to recede horizontally thus leaving an opening for crops to pass through onto a chute leading to the crop conveyor.

In this particular installation the conveyor has a rise of about 1¾ inches per foot and a speed of approximately 38 feet per minute.

Figure 13 illustrates the heavy construction required for the shear gauge. The gauge is motor driven, and is designed for a maximum sheared length of about 21 feet. It is of the screw type, having a bronze nut secured in a saddle casting which slides the entire length of the gauge on side guides. These guides are supported at one end by the shear frame and at the other on a cross beam carried by stands mounted on a foundation.

A feature in connection with this shearing operation is that a weighing scale is located in a pit at the shear runout table. In this design cantilever arms extend from under the table rollers to the weighing scale so that no part of the scale mechanism is under the table where it would be subjected to a deposit of mill scale. These arms may be raised to permit weighing of each slab after cutting. After weighing, the slab is lowered onto the table.

SLAB HANDLING

When cut to the desired length slabs are delivered by a pusher to a transfer as shown on Figure 14. This transfer is approximately 100 feet long measured from centerline to centerline of tables and is about 16 feet wide. Pull racks with disappearing dogs carry the slabs across the transfer to a chute where they slide onto another table as illustrated by Figures 15 and 16.

As shown on Figure 16 three slab pilers are located in the delivery table line. The pilers are of the platform type with screw lifts. After the piles are formed, motor-operated drag-off bars pull them onto skids, from which they are lifted by overhead cranes. Thus, other piles may be formed without delay. Three pilers permit great flexibility in the handling and segregation of the slabs.

Referring back to Figure 12 you will note the very complete system of piping used for lubricating the machinery around the shear. I cannot emphasize too strongly the importance of proper lubrication here, and also at the manipulators and mill tables.

Figure 17 is a view of the motor room. I will leave discussion of details of the equipment shown here to my friends in the electrical engineering profession.

The time allotted me has not permitted delving into the details of construction, so I have confined my remarks to general principles and requirements. Whether a journal should be 6 or 8 inches diameter, or whether a tapered or straight roller bearing, or any other kind of bearing, should be used, are things concerning which there may be different opinions. I will ask the bearing makers, the lubrication experts, the makers of electrical equipment and others engaged in supplying accessories to tell us about the advancement in the art along their respective lines.

FIGURE 16—In the slab yard slabs pass over a delivery table equipped with three slab pilers, giving flexibility in handling.

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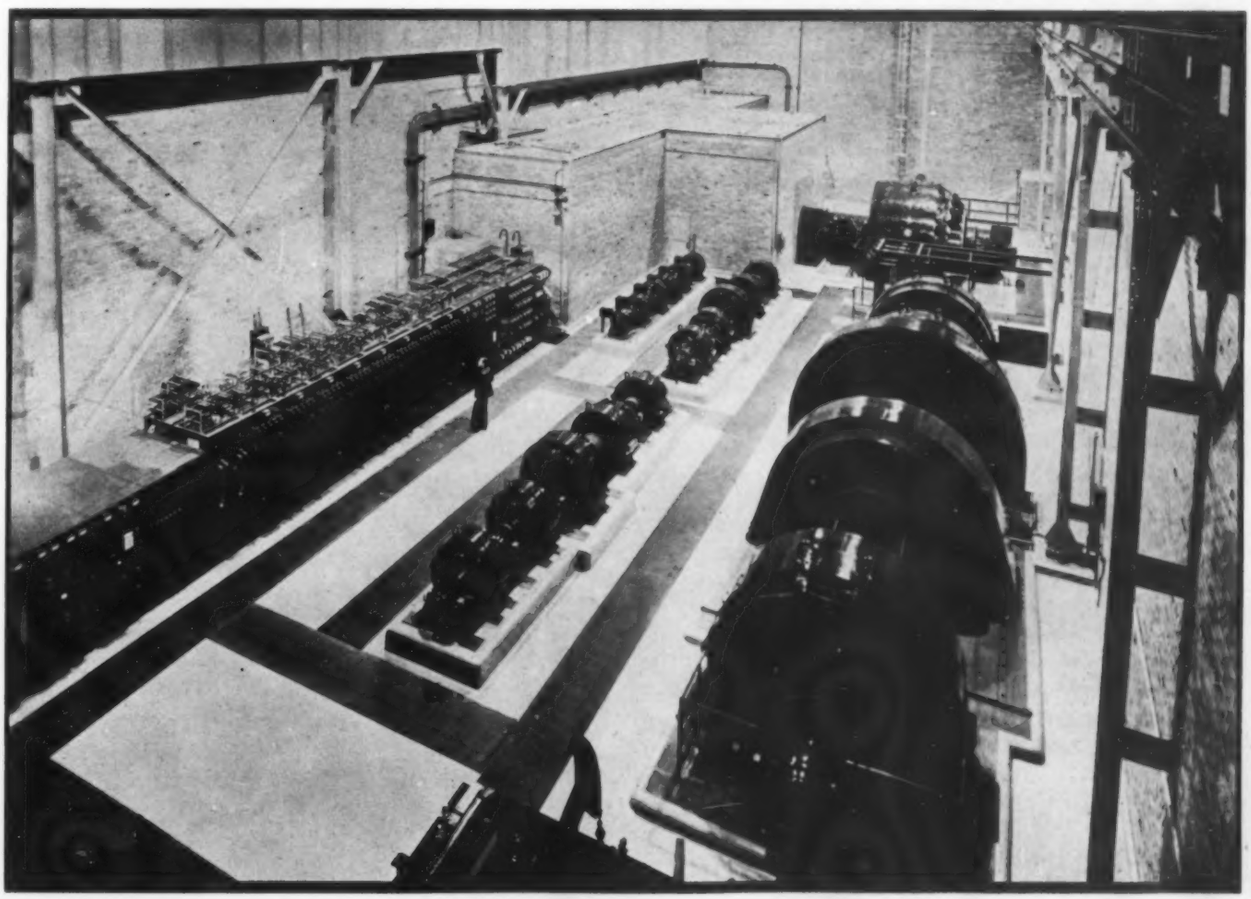
FIGURE 17—View of motor room serving a modern slabbing-blooming mill.



DEVELOPMENTS *in* ROLLING FLAT *Steel* PRODUCTS *in* 1937-38

By STEPHEN BADLAM

Consulting Engineer

PITTSBURGH, PENNA.

Presented before the A. I. & S. E. Annual Convention, Cleveland, O., September 27, 28, 29, 30, 1938

INTRODUCTORY

▲ FOR the past six years the author has presented papers, at the Fall Meetings of the Association, covering the developments in the field of FLAT STEEL ROLLING. Of these papers, four have appeared in the issues of the IRON AND STEEL ENGINEER. Due to causes beyond our control, however, the paper presented at the meeting held in Chicago, in September, 1937 was not published, and for that reason, the present paper will cover the years both of 1937 and 1938.

HOT BROAD STRIP MILLS, UNITED STATES

In the paper presented before the Association, at the September Meeting of 1936, in Detroit, and published in the IRON AND STEEL ENGINEER, of January, 1937, a list was given of twenty five CONTINUOUS SHEET AND HOT BROAD STRIP MILLS in the United States, of which number, twenty one were then in operation. Of the remaining four, three started between that date and January 1st, 1938. These were:

No. 22—96″ Mill, Jones & Laughlin Steel Corp'n., Pittsburgh, Pa., First operated January, 1937.

No. 23—98″ Mill, Republic Steel Corp'n., Cleveland, O., First operated October, 1937.

No. 24—56″ Mill, Bethlehem Steel Co., Sparrows Point, Md. First operated December, 1937.

During 1937, construction was started on three additional mills, all of which went into operation during 1938.

No. 25—48″ Mill, Tennessee Coal Iron & Railroad Co., Fairfield, Ala., First operated March, 1938.

No. 26—44″ Mill, Inland Steel Company, Indiana Harbor, Ind., First operated August, 1938.

No. 27—80″ Mill, Carnegie-Illinois Steel Co., Irvin Works, Dravosburg, Pa., First operated October, 1938.

THE AUTHOR

With the publication of this sixth in a series of articles entitled "Yearly Developments in the Rolling of Sheet and Strip" the Association of Iron and Steel Engineers feel that the author, Mr. Stephen Badlam, has made an outstanding contribution to the literature of the steel industry. We sincerely hope that Mr. Badlam's annual contribution will continue for many more years.

During the year 1938, one new HOT BROAD STRIP MILL has been authorized, and construction started:

No. 28—54″ Mill, Youngstown Sheet & Tube Co., Indiana Harbor, Ind.

The estimated annual capacity of the above twenty eight mills is approximately 16 000 000 net tons.

As far as is known, at the present time, there are no other mills of the type being seriously considered, for construction in the United States, in the immediate future.

Of the mills above mentioned, the following were fully described, and illustrated, in the monthly issues of the IRON AND STEEL ENGINEER, during 1938.

96″ Mill, Jones & Laughlin Steel Corp'n., January.

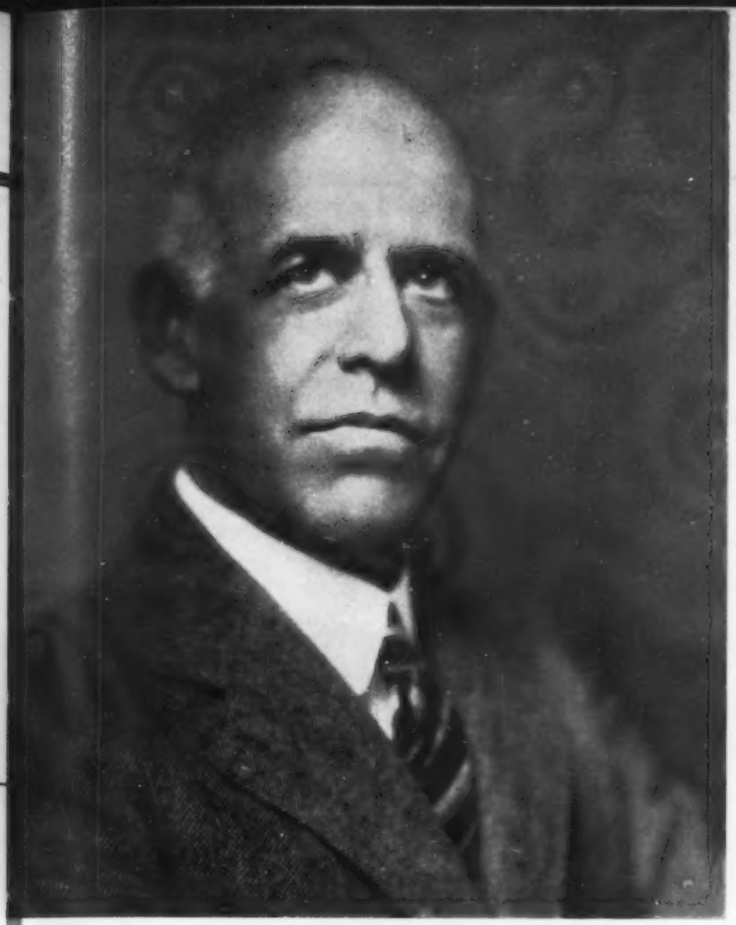
56″ Mill, Bethlehem Steel Co., Sparrows Point, April.

98″ Mill, Republic Steel Corp'n., Cleveland, O., September.

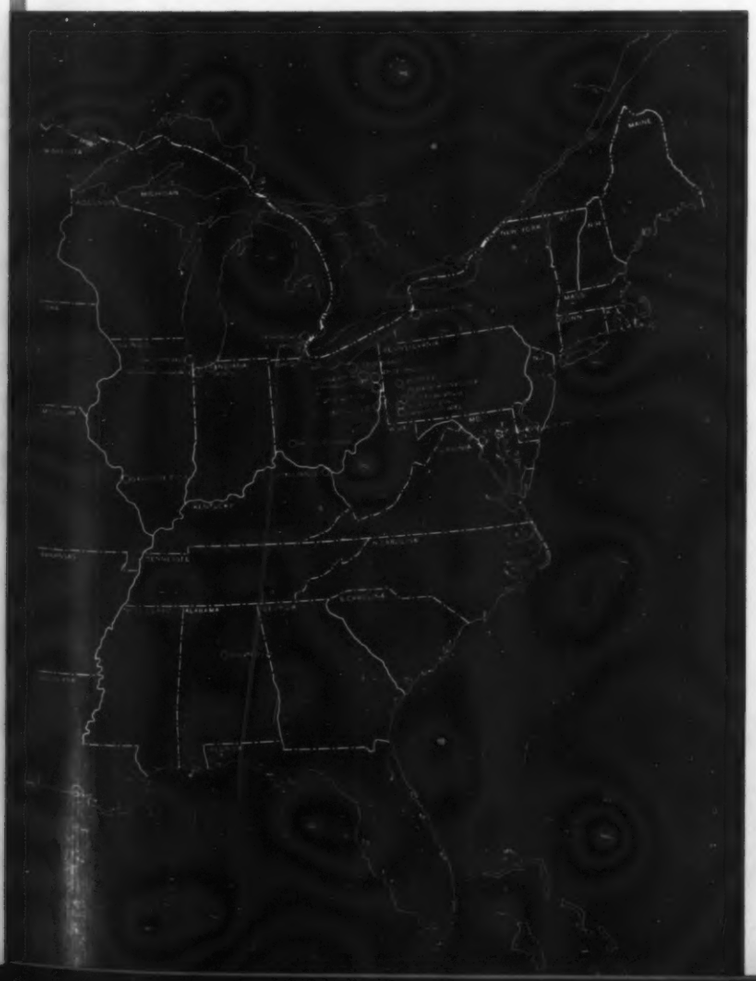
44″ Mill, Inland Steel Co., Indiana Harbor, November.

The Spring Conference of the Association is to be held in Birmingham, Ala., next March, and at that time a full description of the 48″ Mill of the Tennessee Coal Iron & R.R. Co., may be expected.

A brief description, and illustrations, of the Irvin Works appeared in the December, 1938 issue of the



STEPHEN BADLAM



Map showing geographical distribution of the twenty-eight Hot Broad Strip Mills now in operation and under construction in the United States.

IRON AND STEEL ENGINEER, and a fuller description may be expected, at the time of the Fall Meeting, 1939.

GEOGRAPHICAL DISTRIBUTION

The geographical distribution of the twenty eight HOT BROAD STRIP MILLS, now in operation and under construction, in the UNITED STATES, is as follows:

TABLE I GEOGRAPHICAL DISTRIBUTION

DISTRICT	No. of Mills	Annual Capacity N. T.
Eastern, (Sparrows Pt., Md.) District	1	600 000
Northern, (Buffalo, N. Y.) District	1	720 000
Pittsburgh District	5	2 820 000
Youngstown District	3	1 590 000
Cleveland District	2	1 320 000
Chicago District	7	4 260 000
Detroit District	3	1 740 000
Middletown-Ashland District	2	1 032 000
Steubenville-Weirton District	2	1 320 000
St. Louis District	1	320 000
Southern (Fairfield, Ala.) District	1	360 000
TOTAL	28	16 082 000

CARNEGIE-ILLINOIS STEEL CORP'N.

IRVIN WORKS, DRAVOSBURG, PA.

80″ Hot Strip Mill

The latest of the hot strip mills to go into operation is the 80″ Hot Strip Mill of the Carnegie-Illinois Steel Corp'n., at the Irvin Works. The 80″ Hot Strip Mill forms part of a complete plant for the production of hot and cold rolled sheets and strip, and cold reduction tin plates. It represents one of the most extensive construction projects for a single product ever initiated.

The Irvin Works are located on the top of Camden Hill overlooking the Monongahela River, and approximately 225 feet above the mean pool level of the river, at that point. Between the river and the plant site there is located the Pennsylvania Railroad tracks, only slightly above the river level. At a somewhat higher elevation, about 125 feet above the river, are the tracks of the U. S. Steel Corporation owned Union Railroad. About 100 feet above the Union Railroad tracks is the mill site. The Irvin plant is located six miles up the river from the Edgar Thompson Steel Works, the site of the new Universal Slabbing Mill, which is to furnish the raw material, in the form of slabs, for the new strip mill. The two plants are directly connected by the

Table 2, 80″ Hot Strip Mill

		Rolls			Motors			
Stand	Type	Dia.	Lgth.	F.P.M.	H.P.	R.P.M.	Volt	Cur.
SB 1	Hor 2 Hi	32″	66″		1250	240	6600	60 cy.
1	Hor 4 Hi	38″ 51″	130″		3500	150	6600	60 cy.
	Squeezer				350		250	DC
2E	Ver Edg				350	450/900	250	DC
2	Hor 4 Hi	38″ 51″	81″		3500	250	6600	60 cy
3E	Ver Edg				350	450/900	250	DC
3	Hor 4 Hi	34″ 53″	81″		3500	250	6600	60 cy.
4E	Ver Edg				350	450/900	250	DC
4	Hor 4 Hi	34″ 53″	81″		3500	400	6600	60 cy.
	2—Rotary crop shears							
SB 2	Hor 2 Hi	25½″	80″		500	150/600	600	DC
5	Hor 4 Hi	27″ 53″	81″		4500	125/250	600	DC
6	Hor 4 Hi	27″ 53″	81″		4500	125/250	600	DC
7	Hor 4 Hi	27″ 53″	81″	565/1130	5000	80/160	600	DC
8	Hor 4 Hi	27″ 53″	81″	707/1414	5000	100/200	600	DC
9	Hor 4 Hi	27″ 53″	81″	883/1767	5000	125/250	600	DC
10	Hor 4 Hi	27″ 53″	81″	1236/2472	2500	175/350	600	DC
	Rotary flying shear							
	Runout Table, coilers, cooling conveyor							
	Piler and Scale							

3 MOTOR GENERATOR SETS

Motor: 9600 HP .95 PF 360 RPM 6600 V 60 cy syn
Gen: 2-3500 KW 600 V DC

Ward Leonard Control

Union Railroad, which also affords direct connection with all other steel producing plants, of the Carnegie-Illinois Steel Corp'n., in the district.

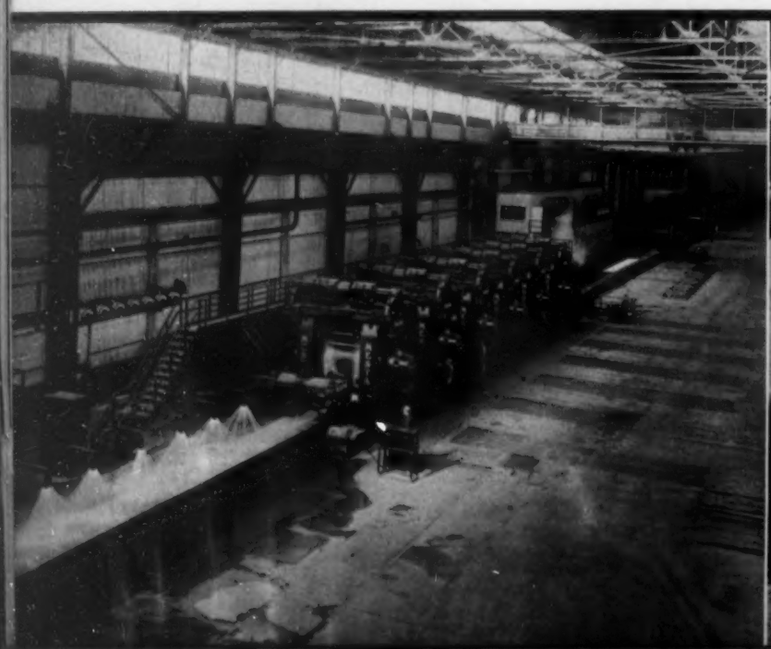
In addition to the rail connection, the new plant is connected by a main power line at 66,000 volts 60 cy. to the electric generating plants at Edgar Thompson and Duquesne Works, and is in convenient proximity to the coke oven gas line from the Clairton By-product Coke Works, thus securing an ample source of electric power, and of fuel gas.

The area of the site reserved for the new plant is approximately 650 acres, of which 51.5 acres are under roof, in the seventeen buildings comprising the plant. Ground was broken on May 22, 1937, and the first structural steel was raised on July 8. The first operation of the plant was on March 2, 1938, when the cold reduction tin mill was started, using strip shipped in from the 43″ Hot Strip Mill, of the McDonald Works.

This plant presents departures from the usual practice in several ways.

First: The plant is located on the top of a hill, instead of being located on low ground, along the river bottom, as has been the usual procedure in the case of an iron or steel plant. This practice dates back to the 17th century when the primitive forges left the forests, with their supply of wood for charcoal, to locate on the banks of a stream, where the water power provided the blast to smelt the ore, and drove the rolling mill, and the river provided the means of transportation for the

Finishing train and universal roughing stand, 80″ Hot Strip Mill, Irvin Works, Carnegie-Illinois Steel Corp., Dravosburg, Pa.



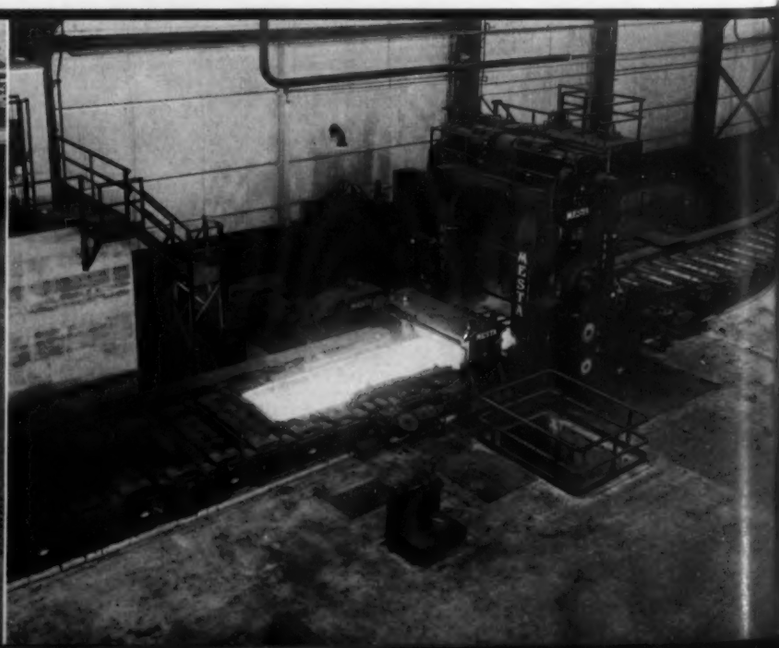


FIGURE 2—Plan view Irvin Works, Carnegie-Illinois Steel Corporation, Dravosburg, Pa.

raw materials required, and for the finished material produced.

Second: Instead of considering it necessary to choose a flat and level site, the designers have taken the previously uneven terrain, and by the moving of approximately 4 500 000 cubic yards of dirt and rock have made an artificial plateau.

Third: The plant is not, as far as present information reveals, to form part of an integrated unit, but on the contrary, will use as its raw material, cold slabs produced at the Edgar Thompson Steel Works, some six miles distant.

The general plan of the present plant is shown in Figure 2, and the published details of the Hot Strip Mill, in Table 2.

YOUNGSTOWN SHEET & TUBE CO.

INDIANA HARBOR WORKS, INDIANA HARBOR, IND.

54″ Hot Strip Mill

Complete details in regard to this mill are not as yet available, but it is reported that it will, in all essential characteristics, be of substantially the same design as the 54″ Mill of the Bethlehem Steel Co., at Sparrows Point, Md.

It will supply hot rolled coils for the cold reduction tin mills, now in operation at the Indiana Harbor plant, as well as for a new, five stand tandem mill, under construction. It will, in addition provide a general line of sheet products, within its width range.

The general characteristics of the mill and drives are shown in Table 3.

HOT BROAD STRIP MILLS, FOREIGN

In the foreign field there are now three mills in operation:

1650 mm, (66″) Mill, Zaporojstal Works, U.S.S.R. This mill is of strictly American design, and largely of American construction. It started operation early in 1938.

1250 mm, (50″) Mill Vereignigte Stahlwerke, Dinslaken, Germany. This mill, while modeled after American design, was built complete in Germany. It started operation early in 1938.

56″ Mill, Richard Thomas, Ltd., Ebbw Vale, South Wales, Great Britain. This mill was designed and largely built in the United States. It started operation Sept. 19, 1938.

Two mills are under construction, at the present time:

43″ Mill, Nippon Steel Co., Yawata, Japan. This mill is being built in the United States.

54″ Mill, John Summers & Co., Chester, England. This mill is likewise under construction in the United States.

It is further reported that a mill of the Broad Strip type is being given serious consideration, for Canada.

YOUNGSTOWN SHEET & TUBE CO.

INDIANA HARBOR WORKS, INDIANA HARBOR, IND.

Table 3, 54″ Hot Strip Mill

Stand	Type	Rolls Dia.	Rolls Lgth.	Motors H.P.	Motors R.P.M.	Motors Volt	Motors Cur.
SB 1	Ver Edg			2–300			SC
1	Hor 2 Hi	40″	54″	3000	144	2300	60 cy syn
2 E	Ver Edg			200	450/900	230	DC
2	Hor 4 Hi	22½″ 45″	54″	2500	240	2300	60cy ind
3 E	Ver Edg			200	450/900	230	DC
3	Hor 4 Hi	22½″ 45″	54″	2500	257	2300	60 cy ind
4 E	Ver Edg			200	450/900	230	DC
4	Hor 4 Hi	22½″ 35″	54″	2500	257	2300	60 cy ind
	2—Crop shears						
SB 2	Hor 2 Hi	24″	54″	500	150/600	600	DC
5	Hor 4 Hi	22½″ 45″	54″	3000	200/400	600	DC
6	Hor 4 Hi	22½″ 45″	54″	3000	200/400	600	DC
7	Hor 4 Hi	22½″ 45″	54″	3000	200/400	600	DC
8	Hor 4 Hi	22½″ 45″	54″	3000	200/400	600	DC
9	Hor 4 Hi	22½″ 45″	54″	3000	200/400	600	DC
10	Hor 4 Hi	22½″ 45″	54″	2000	230/460	600	DC
	Rotary flying shear						
	Runout table, 2 Coilers, Piler and Scale						

2 MOTOR GENERATOR SETS

Motor: 8400 KVA .9 PF 360 R.P.M. 11000 V 60 cy syn.
Gen: 2—3000 KW 600 V DC
Ward-Leonard Control

NIPPON STEEL CO.

YAWATA, JAPAN

43″ Hot Strip Mill

Mention was made in the last paper published of the probable construction of a hot mill, of the BROAD STRIP type, in Japan. The order for this mill was placed with the United Engineering and Foundry Co. during 1937, and is now rapidly approaching completion.

The equipment contracted for includes a Hot Strip Mill, in all essential features identical with the McDonald Mill of the Carnegie-Illinois Steel Corporation, which was built in 1935 and went into operation in December of that year. The rated capacity of the mill is 450 000 tons per year.

In addition to the Hot Mill considerable other equipment has been ordered in the United States.

CHANGES TO EXISTING MILLS

In addition to the distinctly new construction, extensive additions to, and rearrangement of, three existing mills have been made during the past two years. Still more extensive rearrangements to a fourth mill are now under way.

REPUBLIC STEEL CORP'N.

WARREN PLANT, WARREN, O.

42″ Hot Strip Mill

During the year 1937, there were made extensive additions to, and a re-arrangement of, the 36″ Hot Strip Mill at the Warren Plant of the Republic Steel Corp'n.

As will be remembered, this was the second mill, of the BROAD STRIP type, to go into operation, (June 15, 1927) and was made by revamping an existing hot strip mill, of the two high type, built in 1917.

A new roughing train, widened out to permit of rolling 36″ widths, instead of the 30½″ widths previously rolled, together with a new motor, of 3000 H.P., 315/360/405 R.P.M. has been installed. This replaces the original roughing train, and 1500 H.P., 270/360/450 R.P.M. motor, both of which have been in use since 1917.

The intermediate train, formerly consisting of one two high, and two four high stands, has had the two high stand replaced by a new four high stand, and the entire train, together with the 5000 H.P. motor driving it, has been moved to a position immediately preceding the original three finishing stands, so that there are now six four high finishing stands on close centers.

The coilers, and coil handling equipment has been revamped and modernized.

FORD MOTOR COMPANY,
RIVER ROUGE PLANT, DEARBORN, MICH.
66″ Hot Strip Mill

The Ford Motor Company has also made some extensions and improvements to their 56″ Hot Strip Mill, which was built in 1935.

The entire mill has been widened out to 66″, enabling it to produce sheets up to 60″ in width, in place of the 48″, of which the mill as originally built was capable. An additional stand has been added to the finishing train, making a total of six stands, the additional stand being driven by a 3000 H.P. 200-400 R.P.M. 550 V, DC motor, identical with the original motors on the first four finishing stands. The new stand and motor are located preceding the original finishing stands, space having been provided therefor in the original design.

There has also been added a fourth slab heating furnace, 17′ 0″ wide, and 45′ 0″ long, inside, identical with the two original, and one added, furnaces, and designed to operate on either oil or coke oven gas. The new furnace will increase the heating capacity to 120 tons of cold steel per hour.

OTIS STEEL COMPANY
RIVERSIDE PLANT, CLEVELAND, O.
77″ Hot Strip Mill

During the past year and a half extensive changes have been made in the 72″ Otis Steel Co., mill, originally built in 1931.

The entire train has been widened out to a width of 77″. The single four high stand, originally forming the last stand of the roughing train, has been moved to a location immediately preceding the four stand finishing train, and a new four high stand added, following the last finisher, to form a six stand finishing train. Preceding the re-arranged finishing train, a new scale breaker has been added.

Two new motors: 3500 H.P. 175-350 R.P.M. 600 V DC, have been added to drive the two additional finishing stands, and the original 2500 H.P. 200-400 R.P.M. 600 V, DC motor moved to the new finishing stand.

A full description of the additions and improvements to the Otis Steel Co., mill may be found in the September, 1938 issue of the Iron and Steel Engineer.

THE AMERICAN ROLLING MILL CO.
EAST SIDE PLANT, MIDDLETOWN, O.
80″ Hot Strip Mill

In 1935, The American Rolling Mill Co., Middletown, O., initiated a reconstruction program at the East Side Plant, installing in that and the following year, a three stand cold rolling mill for the production of cold finished sheets up to 74″ in width, together with continuous pickler, radiant tube annealing equipment, a skin rolling mill, and auxiliary equipment.

At the same time a program was started for revamping the Hot Strip Mill, to permit of the production of hot rolled coils of corresponding width, and of the maximum possible length. In furtherance of this program, the finishing stands of the mill were widened from 58″ to 80″, and one new 20″ & 46″ x 80″ four high finishing stand was added. A 4000 H.P., 400 R.P.M. 6600 V, 60 cy. A.C. synchronous motor was installed in the 72″ roughing train, replacing a 2000 H.P., D.C. adjustable speed motor which was utilized to drive the last finishing stand.

During 1938 the program was continued, with the addition of two new 4000 H.P., D.C. adjustable speed motors on the finishing train, replacing two of the original 3000 H.P., which in turn were used, one to replace the 2000 H.P. D.C. adjustable speed motor on the last stand of the intermediate train, and one to replace the 2000 H.P. D.C. adjustable speed motor on the last finishing stand previously mentioned.

Further changes are under way in the Hot Strip Mill which will include a re-arrangement of the roughing train, widening all stands to 80″, and the addition of new 5000 H.P. and 4000 H.P. synchronous motors, and a new 2500 H.P. induction motor replacing original motors of 800 to 1200 H.P.

Additional changes under way will include a new two-high reversing slabbing mill.

HOT STRIP MILLS, ENGINEERING FEATURES

From the engineering standpoint, both 1937 and 1938 were decidedly barren years, no development of an outstanding character having been made public, in the field of the Hot Broad Strip Mill.

To revert to the simile employed in the paper of 1934, the past two years have been employed in "a consolidation of the position" gained during the several preceding years. For this reason it may be an appropriate time to summarize some of the engineering features governing the general design of the mills built to date.

As was mentioned in the paper of the above year, the twelve Hot Broad Strip Mills, built up to 1932 show wide variation in the engineering features of their design. The last fifteen mills, on the contrary, with the exception of three, in which special considerations dictated the design, show a marked similarity.

STANDARD DESIGN

This typical, or as one might say, standardized design, comprises, in the order given, the following elements:

Slab heating Furnaces, two or more, generally three in number.

Scale Breaker Stand, generally two high, but in the case of the narrower mills, sometimes a vertical edging stand.

Four 4-Hi. Roughing stands. In the narrower mills the first one, or two of these may be two high.

In the wider mills, 60″ and over, the first of these is a broadsiding, or spreading stand with turntables

on both sides, and followed by a horizontal squeezer.

Three vertical edgers, preceding stands No. 2-3-4.

Tables connecting the stands, of such length that the piece is never in more than a single stand at the one time.

Long Intermediate table, (80 to 160 feet), on which the piece is free of both the preceding and the following stands, and upon which it may be delayed, if so desired.

Two high scale breaker stand.

Six 4-Hi Finishing stands, spaced on close centers, with loopers between, the piece, generally speaking, being in all stands at the one time.

Rotary flying shear, Runout table, Coilers, and piler.

From the given spacing of the stands, it is apparent that AC, constant speed motors will be satisfactory for the roughing stands, and that DC, adjustable speed motors will be required for the finishing stands, including the finishing scale breaker.

The above arrangement, as will be remembered, was, except for the location of the rotary flying shear, the arrangement adopted in the Inland Steel Co., 79″ Mill, built in 1932, and this arrangement, with only minor deviations therefrom, has been generally followed since. The Inland Mill may, therefor, be considered as the prototype of the current HOT BROAD STRIP MILL design.

It is significant also, that three of the older mills have been re-arranged to conform to the Inland type. That this arrangement is not, necessarily, the last word, however, is indicated by developments now in progress.

The three mills built since 1934, and not conforming to type are:

96″ Mill, Granite City Steel Co., Granite City, Ill.

100″ Mill, Carnegie-Illinois Steel Corp'n., Homestead, Pa.

48″ Mill, Tennessee Coal Iron & R.R. Co., Fairfield, Ala.

Six stand, 48″ four high Finishing Mill, Tennessee Coal, Iron & Railroad Co., Fairfield, Alabama.

GRANITE CITY STEEL COMPANY,

GRANITE CITY, ILL.

90″ Hot Strip Mill

The major factors influencing the design of this mill were: First: The fact that the expected maximum production was less than one-half that possible with a mill of the Inland type. Second: The necessity for keeping the capital expenditure down to a figure that would render possible a commensurate return with the reduced production.

In order to accomplish these results, use was made of an existing three high Lauth plate mill, which, with the addition of a separate vertical edging stand, formed the roughing section of the new installation.

The Granite City Mill effected a further economy in first cost by installing four finishing stands only, sacrificing thereby the ability to produce the thinnest gages in the wider widths. Space has been provided, however, for the installation of one, or more, additional finishing stands at some future date, if so desired.

The Granite City Mill comprises:

Slab Heating Furnace, one only, with space for second.

Two high scale breaking stand.

Three high plate mill, roughing stand with

Separate vertical edger.

Intermediate table, about 115 feet.

Two high scale breaking stand.

Four stand, 4 High continuous finishing train.

Runout table, coiler, rotary flying shear and piler.

This mill was fully described and illustrated in the May 1937 issue of the IRON AND STEEL ENGINEER.

CARNEGIE-ILLINOIS STEEL CORP'N.

HOMESTEAD WORKS, HOMESTEAD, PA.

100″ Continuous Plate Mill

This mill was designed for the production of light plates, and while adopting the principles of the HOT BROAD STRIP MILL, was intended for a range of product of a greater thickness than was usual in other mills, excepting, perhaps, the 96″ Plate Mill of the South Chicago Works, of the same company. The Homestead Mill comprises:

Slab Heating Furnaces, three, with space for fourth.

Two high scale breaker stand

Four high Broadsiding stand

Slab squeezer

Vertical Edging stand

Four high Reversing roughing stand

Pinch roll scale breaker

Four stand, 4 High Continuous finishing train

Runout table, lateral transfer, cooling tables and shears.

This mill was fully described and illustrated in the June 1937 issue of the IRON AND STEEL ENGINEER.

TENNESSEE COAL IRON & RAILROAD CO.

FAIRFIELD WORKS, FAIRFIELD, ALA.

Table 4, 48″ Hot Strip Mill

		Rolls			Motors			
Stand	Type	Dia.	Lgth.	F.P.M.	H.P.	R.P.M.	Volt	Cur.
SB 1	Ver Edg	38″	9¾″		1000	600	6600	60 cy
1E	Ver Edg	22″	20¾″	0/928	4000	0/80/160	800	DC
1	Hor 3 Hi	30″ 21″	65″					
SB 2	Hor 2 Hi	32″	48″		500	150/450	600	DC
2	Hor 4 Hi	21″ 48″	48″		2500	175/350	600	DC
3	Hor 4 Hi	21″ 48″	48″		3000	150/300	600	DC
4	Hor 4 Hi	21″ 48″	48″		3500	125/250	600	DC
5	Hor 4 Hi	21″ 48″	48″	687/1374	3500	125/250	600	DC
6	Hor 4 Hi	21″ 48″	48″	824/1648	3000	150/300	600	DC
7	Hor 4 Hi	21″ 48″	48″	962/1924	2500	175/350	600	DC

2 Coilers, Cooling conveyor

MOTOR-GENERATOR SET UNIV. RGH.

Motor: 4900 H.P. PF 514 R.P.M. 6600 V 60 cy syn.
Gen: 2—1750 KW 800 V DC

2 MOTOR-GENERATOR SETS CONT. FIN.

Motor: 8400 H.P. PF 360 R.P.M. 6600 V 60 cy syn.
Gen: 2—3000 KW 600 V DC 1—750 KW 250 V DC

TENNESSEE COAL IRON AND RAILROAD CO

FAIRFIELD WORKS, FAIRFIELD, ALA.

48″ Hot Strip Mill

This mill was designed primarily for the production of hot rolled strip in coils, for further cold reduction to strip for tinning, and secondarily for the production of breakdowns for further hot reduction to sheets in mills of the conventional type. For both tin plates, and for the sheets required for the Southern trade, only a moderate width was demanded. Moreover the total production required was much less than would be possible in a mill of the conventional Broad Strip type.

For these reasons an existing three high universal plate mill was utilized as a rougher, a new scale breaker being installed preceding it. A new finishing train, comprising a scale breaker, and a six stand continuous four high train, with a long intermediate table about 220′ between it and the roughing stand was added. The Tennessee Mill comprises:

Slab Heating Furnaces, three
Vertical edging scale breaking stand
Three high Universal Plate Mill roughing stand
Intermediate table
Two high scale breaking stand
Six stand 4 High Continuous Finishing train
Runout table, Coilers

The available details of this mill are given in Table 4 above.

The resemblance in principle, between these three mills and the original Butler Mill is marked, the principle changes being in the substitution of the three high, or four high rolls, for the original two high rolls, in the roughing stand, and, in the case of the Homestead Mill, the addition of the Broadsiding stand, in this case required on account of the width of the material rolled. In the other two cases a scale breaking stand has been added preceding the finishing train. The Butler Mill, as will be remembered, was provided with a scale breaker, consisting of a roller type leveler. located between the furnaces and the roughing stand. In the later mills this has generally been replaced by a two high roll

Fifth finishing stand, 77″ hot strip mill, Otis Steel Co., Cleveland, Ohio.

TABLE 5

COMPARATIVE TABLE

Showing Total Horsepower and Horsepower Per In.

			Face In.	Roughing		Finishing		Total	
				H.P.	Per in.	H.P.	Per in.	H.P.	Per in.
10	Otis Steel Co. (Revised 1938)....	Cleveland, O.	77	9050	120	20400	265	29450	385
11	Inland Steel Co.....	Indiana Harbor, Ind.	79	13715	174	21500	272	35215	446
13	Youngstown Sheet & Tube Co....	Campbell, O.	79	16215	228	21500	272	37715	500
14	Carnegie-Illinois Steel Corp'n.....	Gary, Ind.	38	8800	231	15000	395	23800	536
15	Ford Motor Co. (Revised 1938)..	Dearborn, Mich.	66	12150	184	18000	273	30150	457
16	Carnegie-Illinois Steel Corp'n.....	McDonald, O.	43	11400	265	19500	454	30900	729
17	Bethlehem Steel Co.....	Lackawanna, N. Y.	79	13715	174	22500	285	35915	459
18	Carnegie-Illinois Steel Corp'n.....	Gary, Ind.	80	16600	208	26300	329	42800	537
19	Great Lakes Steel Corp'n.....	Ecorse, Mich.	96	13715	143	26000	271	39715	414
22	Jones & Laughlin Steel Corp'n....	Pittsburgh, Pa.	96	13715	143	26000	271	39715	414
23	Republic Steel Corp'n.....	Cleveland, O.	98	13900	143	26600	271	40500	414
24	Bethlehem Steel Corp'n.....	Sparrows Pt., Md.	56	13050	234	18500	330	31550	564
26	Inland Steel Co.....	Indiana Harbor, Ind.	44	11050	251	15500	353	26550	604
27	Carnegie-Illinois Steel Corp'n.....	Irvin Works	80	16150	202	27000	338	43150	540
28	Youngstown Sheet & Tube Co....	Indiana Harbor, Ind.	54	11700	217	17500	325	29200	542

stand, and a similar two high stand added preceding the finishing train. In the case of the Tennessee Coal Iron & R.R. Co. mill, the finishing train consists of six stands, in place of the four stands, of the Butler Mill.

MAIN ROLL DRIVE, HORSE POWER

It may be of interest to compare the connected horse power of the main roll drives of the fifteen mills, built since 1931, of the conventional type. In Table 5 there are tabulated the rated horse powers, total and per inch of roll face, for the roughing and the finishing trains, and for the two trains combined. Figure 4 shows the same data in the form of a graph, the abscissas representing the length of roll face, in inches, and the ordinates the corresponding horse power per inch of roll face. These figures are based on name plate ratings, and may, in some cases, be misleading as the overload capacities may not be strictly comparative in different installations.

It will be noted, both from the table, and from the graph, that as would be expected, the total horse power, both for the roughing and for the finishing, is greatest for the wider widths. Also that the horse power per inch of face is greatest for the narrower widths. Thus the three widest mills, (96″ and 98″) all show a total horse power of close to 40 000, or 415 H.P. per inch of face, while the three narrowest mills (38″ to 44″) show from 23 800 to 40 150, or from 536 to 729 H.P. per inch.

The greatest total horse power is found in the Irvin Mill, with 43 150, or 540 H.P. per inch of face, and the greatest H.P. per inch, in the McDonald Mill, with 30 900, or 729 H.P. per inch.

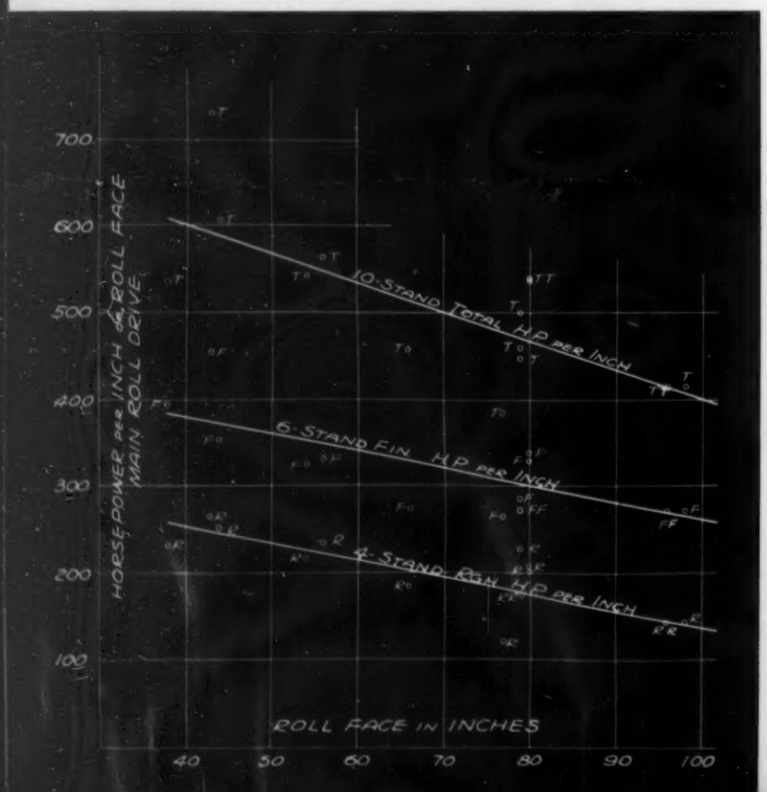


FIGURE 4—Graph showing relation between roll face and connected H.P. per inch for 15 hot strip mills built from 1931 to 1938.

FINISHING SPEEDS

The original Butler Mill had a maximum finishing speed of 928 feet per minute, and the following five mills all had a maximum speed of close to 1000 feet.

The next six mills showed considerable variations in the finishing speed, ranging from 682 feet per minute, for the South Chicago 96″ Continuous Plate Mill, to 1450 feet, for the Great Lakes 38″ Mill. The others of this group ranged in between with from 1230 to 1320 as the top limit.

With the next fifteen mills, the speed limit was rapidly increased, to 1650 in the Ford Mill, 2034 in the McDonald Mill, 2074 in the Great Lakes and Jones & Laughlin 96″ Mills, 2200 in the 44″ Inland Mill, and in the latest mill built, the 80″ Irvin Mill, 2472 feet per minute.

SYNCHRONOUS MOTORS

It is worth noting that, in the case of two of the more recent Hot Broad Strip Mills, synchronous motors, without flywheels, have been used to drive the several stands of the roughing train, instead of the slip ring induction motors, with flywheels, previously considered necessary.

The first application of a synchronous motor to the main roll drive of the Hot Broad Strip Mill, was on No. 5 four high roughing stand of the Otis Steel Co., 72″ Mill, in 1931. This was a 2500 H.P., 240 R.P.M. 11000 V, 60 cy. Machine.

The next application of the synchronous motor was to the 56″ Mill of the Ford Motor Co., in 1935. In this case an induction motor, with flywheel, was still considered necessary on No. 1, broadsiding stand, but synchronous motors were applied to roughing stands No. 2-3-4. The motors used were 3—2500 H.P., 514 R.P.M. 13200 V, 60 cy.

During the past year two installations have been made in which synchronous motors were applied to all four stands of the roughing train. These were:

Bethlehem Steel Co. 56″ Mill, Sparrows Point, Md.

1—3000 H.P., 144 R.P.M. 6600 V, 60 cy.

3—3000 H.P., 514 R.P.M. 6600 V, 60 cy.

Inland Steel Co. 44″ Mill, Indiana Harbor, Ind.

1—2500 H.P., 150 R.P.M. 6600 V, 25 cy.

3—2500 H.P., 375 R.P.M. 6600 V, 25 cy.

As will be seen these two mills are comparatively narrow, and no broadsiding stand is required. One wider mill now in process of reconstruction is also being provided with synchronous motors, one of 5000 H.P., 600 R.P.M., and two of 4000 H.P., 400 R.P.M. 6600 V, 60 cy., on stands 2-3 and 4 of the roughing train.

ROTARY FLYING SHEAR

There is one point in the arrangement of these mills upon which we may profitably comment, the location of the rotary flying shear.

In the earlier mills, in which a rotary flying shear formed part of the layout, the Steubenville Mill, and the Great Lakes 38″ Mill, the rotary flying shear was placed at some distance from the finishing stand, about 70 feet, and its synchronization with the finishing stand was not required to be exact. In the Inland Mill, the rotary flying shears were removed entirely from the mill runout line, and placed, one on each of the two offset side lines. This presumably, was on account of expected difficulties in delivering the short lengths from the shear over a long stretch of roller table, to the pilers, as well as in the synchronization of the shear with the finishing roll stand.

The first mill in which the rotary flying shear was placed in immediate proximity to the finishing stand was the 38″ Mill, of the Allegheny Steel Co., in which it was placed at a distance of approximately 10 feet, and exactly synchronized with the last stand, the latter in fact, performing the function of a feed roll to the shear. The first typical strip mill in which this arrangement was employed was the 79″ Mill of the Youngstown Sheet & Tube Co.

In the newer mills the rotary flying shear is located close to the finishing stand, the cut lengths then traveling along the runout table to the piler, in the case of the Republic 98″ Mill, a distance of some 700 feet.

BLOOMING AND SLABBING MILLS

An essential element in the successful operation of the modern Hot Broad Strip Mill is the ability to furnish an adequate supply of slabs, of the maximum possible width, whereby the necessity of broadsiding in the Hot Strip Mill is reduced to a minimum. Few plants possess Universal Slabbing Mills, capable of supplying slabs from 48″ to 60″ in width, and those plants relying upon Blooming Mills, were limited to widths of not over 42″ and usually of not over 36″.

The result has been that, with the increasing demand for wide slabs, 42″ to 60″, during the past few years, the construction of Blooming Mills, of an improved type, to furnish such slabs, has become an important part of the construction programs of the companies engaged in the production of Broad Strip.

These new Blooming Mills all have one feature in common, a very high lift to the top roll, from 48″ to 60″. This permits of the edging of slabs of a width substantially equal to that possible in any of the existing Universal Slabbing Mills.

It had been my intention to describe, in some detail, the new Blooming Mill installations, with particular reference to the changes in design incident to their use in producing slabs for the Broad Strip Mills. Mr. Iversen's paper, read at the Cleveland meeting, last September, however renders such detailed description unnecessary. The following, therefor, will be limited to a brief summary of such new construction.

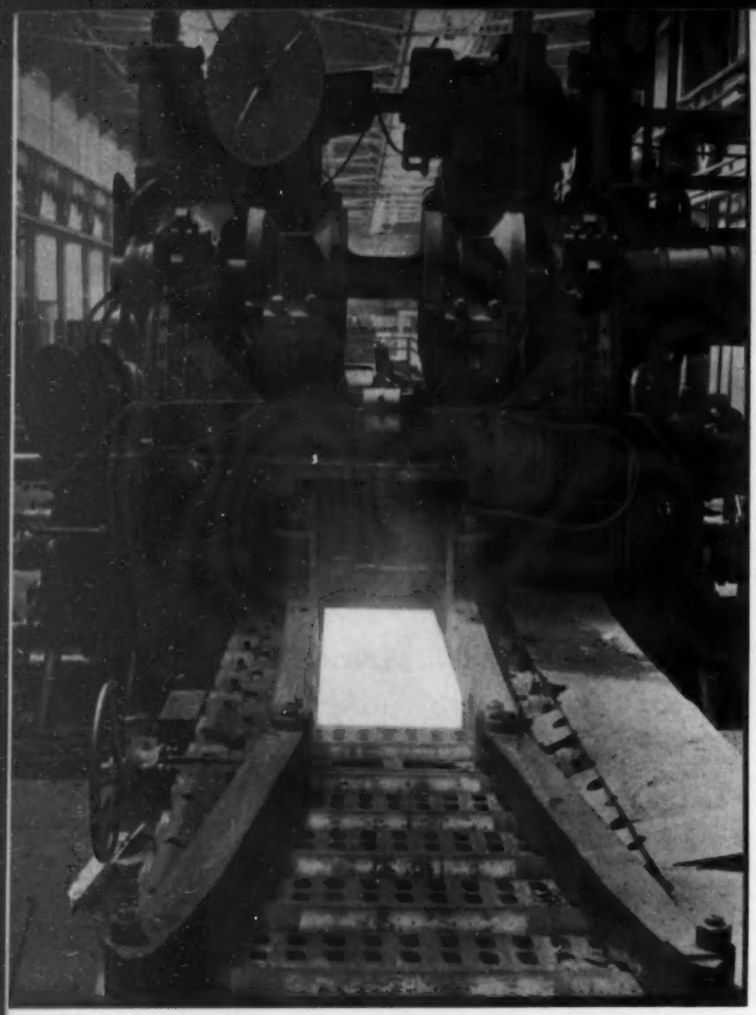
JONES & LAUGHLIN STEEL CORP'N.

PITTSBURGH, PA.

44″ Reversing Blooming Mill

The Jones & Laughlin Steel Corp'n., in 1935, constructed a new 44″ 2-High reversing Blooming Mill, at the South Side Works, to provide slabs for the 96″ Hot Broad Strip Mill, at Hazelwood, directly across the river. Slabs may be rolled to a maximum width of 54 inches.

The new mill replaced a three high blooming mill built in 1897, and is driven by a new motor and fly wheel Motor generator set, replacing the old steam engine drive.



Single stand three high Universal Roughing Mill, Tennessee Coal, Iron & Railroad Co., Fairfield, Alabama.

REPUBLIC STEEL CORP'N.

CORRIGAN MCKINNEY PLANT, CLEVELAND, O.

44″ Reversing Blooming Mill

To supply slabs for the new strip mill, a new 44″ Blooming Mill was installed in the Corrigan McKinney Plant replacing an old 40″ reversing mill, originally built in 1915. The mill is driven by the 12 000 H.P. steam engine used on the old mill, and existing pinions were used on the new roll stand. The new mill will produce slabs from 34″ to 48″ in width.

The mill is served by nine blocks of soaking pits, totalling thirty five holes, having a combined capacity of 154 24″ x 48″ ingots.

INLAND STEEL COMPANY

INDIANA HARBOR, IND.

46″ Reversing Blooming Mill

The Inland Steel Co., added during the year 1937 a new 46″ x 104″ Two High Reversing Blooming Mill, to provide slabs for the 79″ Hot Strip Mill, and also for the new 44″ Hot Strip Mill, which was completed last year.

The new mill is located in line with, and preceding, the 79″ Mill, and between it and the 44″ Mill, the Blooming Mill and the two strip mills having a common slab yard. The new Blooming Mill is capable of producing slabs up to 54″ in width.

It is provided with nine, 16′ Dia. single hole circular pits, having a capacity for 10 ingots 26″ x 54″, each. Space is further provided for 6 additional pits of the same type and size.

GREAT LAKES STEEL CORP'N.

ECORSE, MICH.

46″ Blooming Mill

The Great Lakes Steel Corp'n. completed in 1938, a new 46″ Two High Reversing Blooming Mill, to furnish slabs for the 96″ Hot Strip Mill, which went into operation in 1936. The new Blooming Mill is located in line with, and preceding, the Hot Strip Mill, connecting tables being provided, so that slabs may be rolled into the heavier gages of sheets, if so desired without reheating. This mill is capable of rolling slabs up to 62″ in width.

TENNESSEE COAL IRON & RAILROAD CO.

FAIRFIELD WORKS, FAIRFIELD, ALA.

46″ Reversing Blooming Mill

The Tennessee Coal Iron & R. R. Co., has completed a new 46″ reversing blooming mill, at the Fairfield works to furnish slabs for the new 48″ Hot Strip Mill. This mill is in addition to the 40″ 2 High reversing mill, at that plant, built in 1917.

STEEL COMPANY OF CANADA

HAMILTON, ONTARIO

44″ Reversing Blooming Mill

During 1937, the Steel Company of Canada installed a new 44″ 2-High Reversing Blooming Mill, supplementing the 34″ Reversing Blooming Mill which has been in operation for twenty four years. The new Blooming Mill is located preceding the 34″ Blooming Mill, at a distance of 190 feet, four of the old soaking pits being removed to make room for the new mill, and four new soaking pits being installed adjacent to the remaining pits farthest from the mill.

The new mill is capable of producing slabs up to 51″ in width.

The mill was built in Canada, by the Dominion-United Engineering Co., and is essentially a duplicate of the mills built by the United Eng. & Fdy. Co., for the Ford Motor Co., Richard Thomas, Ebbw Vale, South Wales, and for the Republic Steel Corp'n., at the Corrigan-McKinney Works.

CARNEGIE-ILLINOIS STEEL CORP'N.

EDGAR THOMPSON WORKS, BESSEMER, PA.

45″ Reversing Universal Slabbing Mill

The Carnegie-Illinois Steel Corp'n., in order to provide slabs for the new Irvin Works, has built at the Edgar Thompson Works, a new Universal Slabbing Mill, with rolls 45″ x 80″, and capable of producing slabs up to 60″ in width, and up to 45 000 lbs. in weight. The rated annual capacity of the mill is 1 000 000 G. T.

The mill is driven by two 5000 H.P. motors, each driving one roll, in a manner similar to that first applied to the 44″ Universal Slabbing Mill built at the South Chicago Works, in 1931. The vertical rolls are driven by one 3000 H.P. motor.

THE AMERICAN ROLLING MILL CO.

EAST SIDE WORKS, MIDDLETOWN, O.

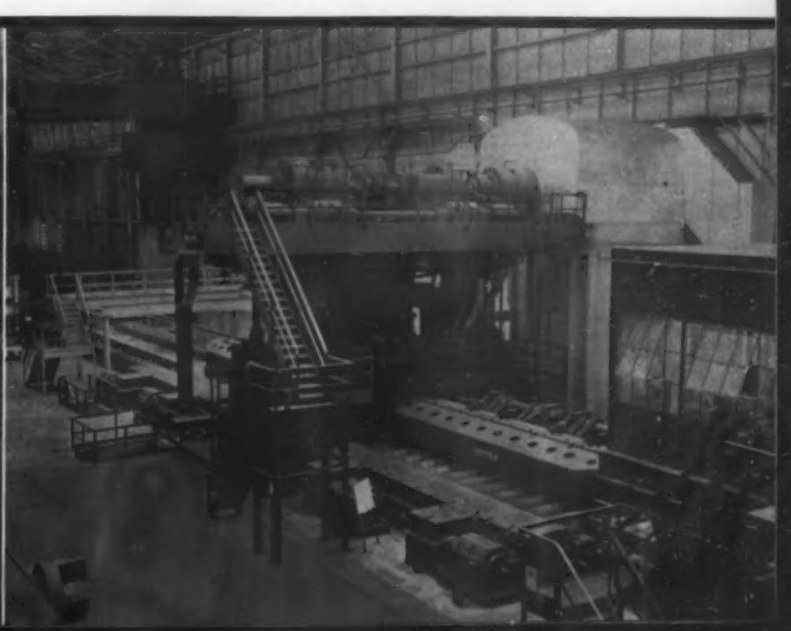
45″ Reversing Slabbing Mill

As previously mentioned, The American Rolling Mill Co. has under construction, a new 45″ x 120″ Two high reversing slabbing mill, with separate vertical edging stand.

The new slabbing mill will be driven by two 5000 H.P. 0/49/80 R.P.M. DC motors on the main rolls, each roll being driven independently, by its own motor. The vertical edging stand will be driven by a 2000 H.P. 0/100/200 R.P.M. motor. All three motors will be driven from one Fly Wheel Motor-Generator Set.

The new Slabbing Mill will replace the old 40″ Reversing Blooming Mill, with steam engine drive, which was built at the time of the construction of the East Side Plant, in 1911.

Below are shown two views of the new 45″ reversing universal slabbing mill of the Carnegie-Illinois Steel Corporation Edgar Thomson Works. The entry side is shown at the left while at the right is pictured the delivery side.



YOUNGSTOWN SHEET & TUBE CO.

INDIANA HARBOR WORKS, INDIANA HARBOR, IND.

46″ Reversing Blooming Mill

In order to provide slabs of the maximum width, 48″, for the new Hot Strip Mill, at the Indiana Harbor Plant, the Youngstown Sheet & Tube Co., has under construction a new 46″ x 100″, 2-High Reversing Blooming Mill.

The new mill will replace the 35″ 2-High Reversing mill built in 1916. The motor drive for this mill was rebuilt in 1929, (to 8000 H.P. 0/40/80 R.P.M. 700 V. DC) and will presumably be used to drive the new mill.

COLD REDUCTION SHEET MILLS

From the technical standpoint there is little that can be said on the subject of Cold Reduction Sheet Mill developments during the past two years. The mills proper have been of substantially the same type as those built during the past several years. Such advances as have been made have been in the direction of increased horse power and increased speed.

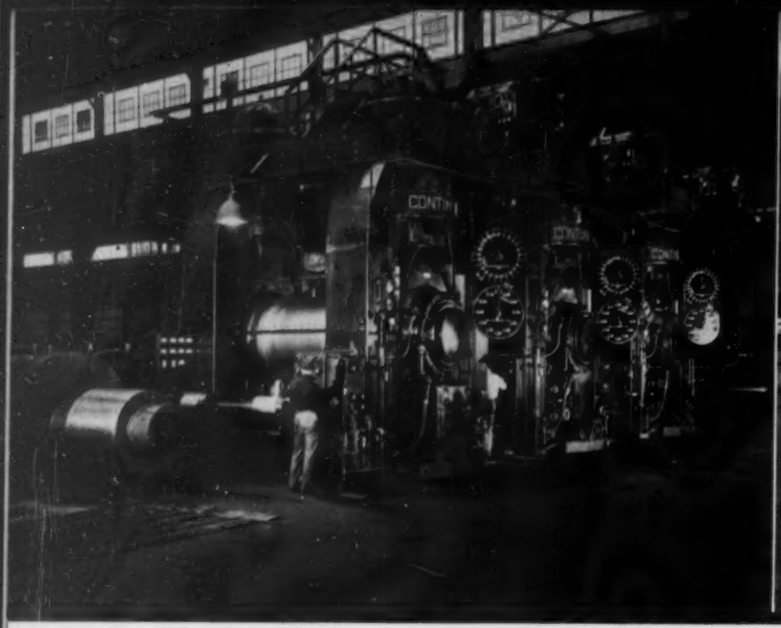
The only strictly new construction has been the cold reduction sheet mills for the new Irvin Works, which were ordered in 1937, and went into operation late in 1938. 1938 was a particularly barren year for new construction, no mills for the heavy reduction of sheet width material having been ordered, or built, within the past year, for use in the United States, although several have been built for use abroad.

Some changes have been made in existing mills, particularly in the direction of providing increased power, and in one case, increased width. Some few mills have been purchased for Temper Pass, or Skin Rolling sheet width material.

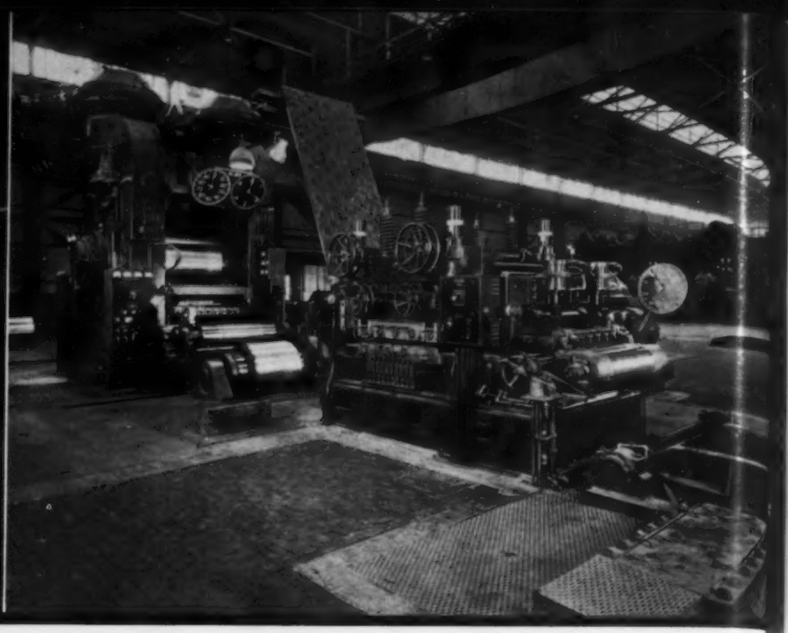
CARNEGIE-ILLINOIS STEEL CORP'N.

IRVIN WORKS, DRAVOSBURG, PA.

The cold reduction department, of the Irvin Works, comprises two divisions, the one for sheet width material, and the other for tin plates. Each of these has



84″ three stand cold reduction mill, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pennsylvania.



Entry end 54″ reversing mill, cold reduction department, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pennsylvania.

its own separate reduction and temper pass mills, annealing department, and finishing equipment.

Two separate pickling lines are provided, one for widths up to 77″, and the other for widths up to 38″, located at right angles to, and connecting, the Hot Strip Mill, and the Cold Reduction Department.

COLD REDUCTION SHEET MILL

The cold reduction equipment, for the production of sheets and wide strip comprises:

One 84″ 3-Stand 4-High Tandem Cold Mill
One 54″ Single 4-High Reversing Mill
Two 84″ Single 4-High Temper Pass Mills, for coils or sheets.
One 84″ Single 4-High Temper Pass Mill, for sheets
One 84″ Single 2-High Temper Pass Mill, for coils or sheets

In addition there are located in the Hot Mill finishing department:

One 84″ Single 2-High Temper Pass Mill, for coils or sheets

One 84″ Single 2-High Temper Pass Mill, for sheets

Each of the Temper Pass mills is provided with a leveler following the roll stand.

The characteristics of the above mills, and drives, are shown in Tables 6-7-8-9-10-11, following:

In addition to the cold mills proper, there are:
3 Electro-cleaning lines

34 Radiant Tube type annealing furnaces, with 118 bases and hoods

One combination open annealing and normalizing furnace

3 Side trimmer and flying shear lines

One trimmer and recoiler

Stretcher leveler, roller levelers.

Squaring shears, and oiling machines.

42″ five stand cold reduction mill, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pennsylvania.

Number 3 two stand tandem tin temper mill, Carnegie-Illinois Steel Corporation, Irvin Works, Dravosburg, Pennsylvania.

TABLE 6, 84″ TANDEM COLD MILL

Stand	Type	Rolls Dia.	Lgth.	F.P.M.	Motors H.P.	R.P.M.	Volt	Cur.
1	Hor 4 Hi	20½″	56″	84″	2500	225/450	600	DC
2	Hor 4 Hi	20½″	56″	84″	3500	175/350	600	DC
3	Hor 4 Hi	20½″	56″	84″	2500	225/450	600	DC
	Tension Reel			450/900	800	250/750	600	DC

MOTOR-GENERATOR SET

Motor: 10650 H.P. 360 R.P.M. .95 PF. 6600 V, 60 cy syn.
Gen: 2—3500 KW, 600 V, DC, Main 1—200 KW 185 V, Reel Booster
1—150 KW, 185 V, DC, Entry Booster 1—100 KW 250 V, Exciter

TABLE 7, 54″ REVERSING COLD MILL

Stand	Type	Rolls Dia.	Lgth.	F.P.M.	Motors H.P.	R.P.M.	Volt	Cur.
	Tension Reel				1250/1750	150/525	600	DC
	Hor 4 Hi	20½″	54″	54″ 500/1000	3500	150/300	600	DC
	Tension Reel				1250/1750	150/525	600	DC

MOTOR-GENERATOR SET

Motor: 5500 H.P. 360 R.P.M. .95 PF 6600 V, 60 cy. syn.
Gen: 1—3000 KW 600 V DC Main 1—1000 KW 400 V DC Booster. 1— 100 KW 250 V DC Exciter

TABLE 8 84″ TEMPER PASS MILLS NO. 1-2

Stand	Type	Rolls Dia.	Lgth.		Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel			Drag Gen.	2-53.5 KW	600/1800	172	DC
	Hor 4 Hi	20½″	48″	84″	125	450/1200	230	DC
	Tension Reel				450	375/1000	375	DC

MOTOR-GENERATOR SET

Motor: 700 H.P. 1200 R.P.M. .95 PF 440 V 60 cy.
Gen: 125 KW 250 V Main. 350 KW 350 V Booster 15 KW 250 V Exciter

TABLE 9 84″ TEMPER PASS MILL NO. 3

Stand	Type	Rolls Dia.	Lgth.	Motors H.P.	R.P.M.	Volt	Cur.
	Hor 4 Hi	20½″	48″ 84″	125	450/1200	230	DC

TABLE 10 84″ TEMPER PASS MILLS NO. 4-5

Stand	Type	Rolls Dia.	Lgth.		Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel			Drag Gen.	2-53.5 KW	600/1800	172	DC
	Hor 2 Hi	32″	84″		125	450/1200	230	DC
	Tension Reel				450	375/1000	375	DC

MOTOR-GENERATOR SET

Motor: 700 H.P. 1200 R.P.M. .95 PF 440 V 60 cy.
Gen: 125 KW 250 V Main 350 KW 350 V Booster 15 KW 250 V Exciter

TABLE 11 84″ TEMPER PASS MILL NO. 6

Stand	Type	Rolls Dia.	Lgth.	Motors H.P.	R.P.M.	Volt	Cur.
	Hor 2 Hi	32″	84″	125	450/1200	230	DC

TABLE 12 54″ SINGLE SKIN PASS MILL

Stand	Type	Rolls Dia.	Rolls Lgth.		Motors H.P.	Motors R.P.M.	Motors Volt	Motors Cur.
	Feed Reel			Drag Gen.	2–25 KW	450/1800	300	DC
	Hor 4 Hi	20½″	49″ 54″		500	500/1000	600	DC
	Tension Device				2–150	575/1150	600	DC
	Tension Reel				300	225/900	600	DC

MOTOR-GENERATOR SET

Motor: 1100 H.P. .8 PF 900 R.P.M. 6600 V 60 cy. syn.
Gen: 750 KW 600 V DC

WEIRTON STEEL COMPANY

WEIRTON PLANT, WEIRTON, W. VA.

54″ Single Skin Pass Mill

The Weirton Steel Co., has quite recently placed an order for one 54″ single skin pass mill for sheet widths. This mill will be equipped with drag generators, for back tension, and with a tensioning device between the rolls and the reel, and is, I believe, the first time that a mill for sheet width material, as distinguished from strip for tinning, has been so equipped. The general characteristics of the mill and drive are indicated in Table 12 above.

CHANGES TO EXISTING MILLS

Among the mills in which changes to the equipment have been made, during the past two years, the following may be mentioned:

OTIS STEEL COMPANY

CLEVELAND, O.

Cold Strip Mill

The Otis Steel Company, co-incident with the extensions and improvements to the Hot Strip Mill, have made extensive changes in the cold rolling mill, a new third stand, 21″–52″ x 77″ has been added, and the two original stands enlarged to the same size. One new motor, for the new third stand, of 1250 H.P. 250/612 R.P.M. 600 V. DC, and a new reel motor, of 250 H.P. 300/1350 R.P.M. 600 V DC. has been added. A belt wrapper has been installed on the reel.

The combined changes are reported as doubling the former capacity of the cold mill.

FORD MOTOR COMPANY

RIVER ROUGE PLANT, DEARBORN, MICH.

66″ Cold Strip Mill

At the same time that the Hot Strip Mill, of the Ford Motor Company was widened out to 66″, the three stand tandem cold strip mill was widened out to a corresponding figure. A belt wrapper has also been provided for entering the strip on the reel. Outside of the increase in width, the other characteristics of the mill and drive remain as they were originally.

The Ford Motor Company has also purchased twelve additional Bell Type, Electric Annealing Furnaces, making a total of 38 furnaces of this type. Each furnace is rated at 230 KW, and can anneal two coils, 52″ in dia., and 48″ high and having a combined weight of 32 000 Lbs.

INLAND STEEL COMPANY
INDIANA HARBOR WORKS, INDIANA HARBOR, IND.

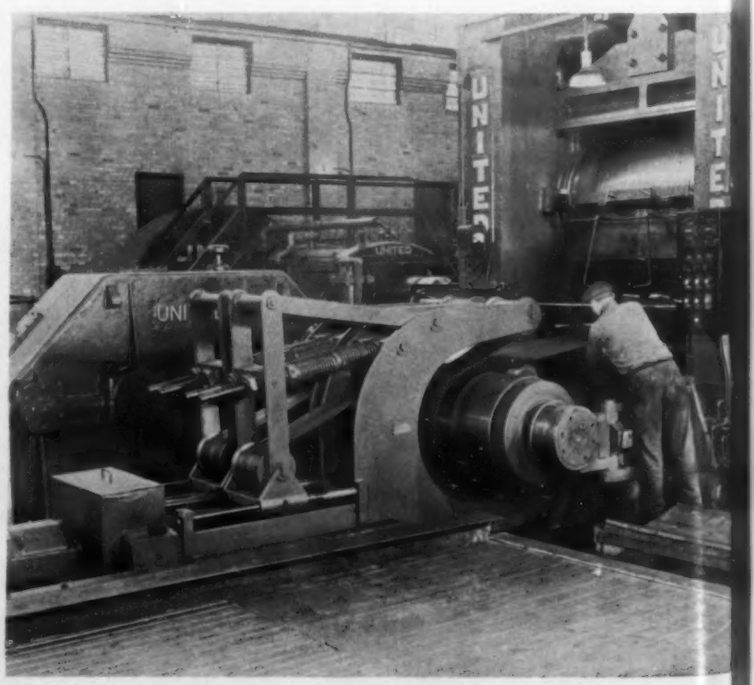
Cold Strip Mill

During 1937, the Inland Steel Company, made extensive changes in the motor equipment, on their tandem cold strip mills, which were built in 1931.

The 72″ 3-Stand Tandem train, which was originally the 42″ train, with motors of 500 H.P., is now equipped with 1250 H.P. 400/800 R.P.M. 600 V DC motors.

The 54″ Tandem train has had the original three stands increased to four, one new stand with 1250 H.P. 400/800 R.P.M. motor has been added, and two of the original 500 H.P. motors have been replaced by one 750 H.P., and one 800 H.P. motors.

Double belt wrapper in position around tension reel receiving strip at 77″ tandem cold mill, Otis Steel Company, Cleveland, Ohio.



GRANITE CITY STEEL COMPANY

GRANITE CITY, ILL.

Cold Strip Mill

The Granite City Steel Company has recently placed orders for extensive additions to the cold rolling department, originally built in 1935-6. One new 16½″ and 53″ x 48″ single stand, reversing 4 Hi cold strip mill, duplicating the original mill, has been ordered, together with one 18″ and 53″ x 48″ single stand, skin pass mill, this latter being so designed that a future second stand may be added, converting it into a two stand tandem.

COLD REDUCTION TIN PLATE

During the past two years there has been a very considerable increase in productive capacity for cold reduced tin plate.

During 1937, The Bethlehem Steel Co., at the Sparrows Point Plant, placed in operation the second of their two 5-Stand Tandem cold reduction mills.

The Wheeling Steel Co., at the Yorkville Plant, also started their second 5-Stand mill, and dismantled their first 4-Stand mill, originally built in 1930.

The Republic Steel Corp'n., early in 1937, started their 4-Stand cold reduction mill, at the Niles, O., plant.

Early in 1938, the Tennessee Coal Iron & R. R. Co., started their two 5-Stand Tandem trains at the Fairfield Works, this being the first plant for the production of tin plate South of the Ohio River.

The Carnegie-Illinois Steel Corp'n., early in 1938, started operations at the Irvin Plant, the 5-Stand Tandem cold reduction mill, for tin plate, going into operation on March 2.

Under construction at the present time is a 5-Stand 48″ tandem mill, for the Youngstown Sheet & Tube Co., at the Indiana Harbor Works.

SKIN ROLLING OF STRIP

During the past few years revolutionary changes have been made in the temper rolling, or skin passing, of strip of tin plate gages.

It is apparent that temper rolling of strip, of a thickness of .01″, and in the dead soft condition from the annealing, at a speed of 1500 feet per minute, is an operation requiring an exceedingly accurate manipulation. The amount of reduction to secure the desired stiffness, and the tension required to secure a perfectly flat delivery, must be held within extremely close limits to avoid stretching or tearing the strip. Add to this the requirement of complete freedom from coil breaks, scratches, or other surface imperfections, and the difficulty of the task becomes evident. To accomplish this a degree of complexity in the electrical equipment is required that was literally undreamed of only a few years ago.

The modern skin rolling mill is equipped with a feed reel, generally of the double cone type, in which constant back tension is maintained on the strip entering the rolls, by means of two drag generators. The rolls themselves are driven by a separate motor. Forward tension of the strip delivered from the rolls is maintained by means of a pulling, or tensioning device, driven by a separate motor, and entirely independent of the pull of the reel, which in turn is driven by its motor in such manner that there shall be no slippage which would mar the surface of the strip.

In some few installations there is an additional tensioning device between the feed reel and the rolls,

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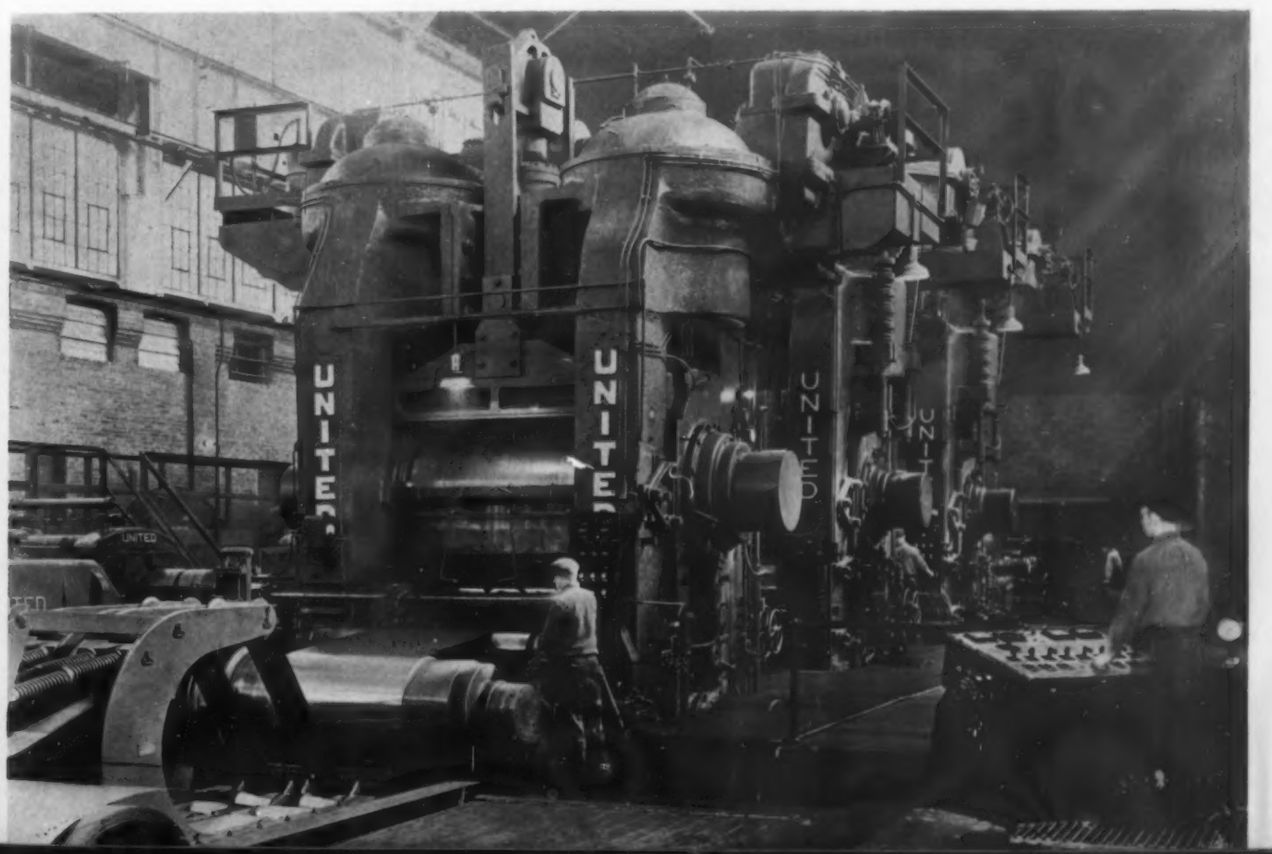
Otis Steel Company's 77″ cold strip mill showing new finishing stand installed during 1938.



whereby the tension on the entering strip is regulated independently of the pull of the rolls. Thus we have three separate motors, and either two or three drag generators, all of which must be perfectly co-ordinated both as to speed and torque.

The use of back tension, by means of drag generators, and forward tension, by means of a separate pulling device, between the rolls and the reel, is now almost universal in the temper rolling of strip tin plate. The two stand temper pass mill has also come into very general use there being now at least fifteen of these mills in use.

For strip of sheet width and gage, however, the use of the single stand mill, without separate tensioning devices, is the general practice, the material being processed either in coil form, with the use of a reel, or in the form of single sheets. The first exception to this is the Weirton Skin Pass Mill, mention of which was made earlier in the paper.

BETHLEHEM STEEL CO.

MARYLAND PLANT, SPARROWS POINT, MD.

Cold Reduction Mill

The Bethlehem Steel Co., late in 1937, placed in operation at the Sparrows Point Plant the second 5-Stand tandem mill, together with two 2-Stand 4-High Tandem Skin Pass mills, making a total of two 5-Stand Tandem, two 2-Stand Skin Pass, and two single skin pass mills.

A comparison of the two 5-Stand tandem mills, built only two years apart, is of interest in indicating the direction and amount of the changes in design, which have taken place during that period. The two installations, as far as concerns the roll stands proper, are identical. The connected horse power on the 1935 installation was 4000 H.P., and on the 1937 installation, 4750 H.P., an increase of about 20%. The finishing speed of the earlier installation was 691 to 1151, and of the later mill, 1152 to 1536 feet per minute, an increase of about 34%. The rated capacity is 11 000 N.T. per month for the earlier mill, as against 14 000 N.T. per month, for the later mill, an increase of about 27.5%.

The characteristics of these mills are given in Tables 13, 14, 15, and 16.

WHEELING STEEL CORP'N.

YORKVILLE PLANT, YORKVILLE, O.

Cold Reduction Tin Mill

The Wheeling Steel Corp'n. has placed in operation their second 5-Stand 4-High Tandem cold reduction mill for tin plates, at the Yorkville Works.

Table 13 42″ 5-Stand Tandem No. 1

Stand	Type	Rolls Dia.		Lgth.	F.P.M.	H.P.	Motors R.P.M.	Volt	Cur.
	Coil Box								
1	Hor 4 Hi	18″	49″	42″	138/231	800	600/1000	600	DC
2	Hor 4 Hi	18″	49″	42″	275/457	800	600/1000	600	DC
3	Hor 4 Hi	18″	49″	42″	451/752	800	600/1000	600	DC
4	Hor 4 Hi	18″	49″	42″	648/1081	800	600/1000	600	DC
5	Hor 4 Hi	18″	49″	42″	691/1151	800	600/1000	600	DC
	Tension Reel					150/225	225/900	600	DC

MOTOR-GENERATOR SET

Motor: 4800 KVA .8 PF 750 R.P.M. 6600 V cy. syn.
Gen: 2—1250 KW 600 V DC Main 1000 KW 250 V DC. Mill Supply
Exciter Set 60 KW 250 V DC.

TABLE 14 42″ 5-STAND TANDEM NO. 2

Stand	Type	Rolls Dia.		Lgth.	F.P.M.	H.P.	Motors R.P.M.	Volt	Cur.
	Coil Box								
1	Hor 4 Hi	18″	49″	42″	260/347	500	600/800	600	DC
2	Hor 4 Hi	18″	49″	42″	414/552	1000	600/800	600	DC
3	Hor 4 Hi	18″	49″	42″	691/921	1000	600/800	600	DC
4	Hor 4 Hi	18″	49″	42″	980/1307	1000	600/800	600	DC
5	Hor 4 Hi	18″	49″	42″	1152/1536	1250	600/800	600	DC
	Tension Reel					150/225	225/900	600	DC

MOTOR-GENERATOR SET

Motor: 28150 KVA .8 PF 300 R.P.M. 6600 V 60 cy. (of Frequency Changer)
Gen: 3500 KW 600 V DC

Table 15 42″ Single 4-High Skin Pass No. 1-2

Stand	Type	Rolls Dia.		Lgth.	F.P.M.	Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel								
	Hor 4 Hi	18″	49″	42″	790	500	900	600	DC
	Tension Dev					150	400/800	600	DC
	Reel					100/125	300/1200	600	DC

MOTOR-GENERATOR SET

Motor: 1425 KVA .8 PF 750 R.P.M. 6600 V 25 cy. syn.
Gen: 2—500 KW 600 V DC

TABLE 16 42″ 2-STAND TANDEM SKIN PASS NO. 3-4

Stand	Type	Rolls Dia.		Lgth.	F.P.M.	Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel					2-25 KW	450/1800	230	DC
1	Hor 4 Hi	18″	49″	42″		200	250/375	230	DC
2	Hor 4 Hi	18″	49″	42″	1194/1791	200	250/375	230	DC
	Ten Dev					200	250/375	230	DC
	Reel					100/125	300/1200	230	DC

MOTOR-GENERATOR SET

Motor: 1425 KVA .8 PF 750 R.P.M. 6600 V 25 cy. syn.
Gen: 2—500 KW 250 V DC

The Wheeling Steel Corp'n., was probably the earliest company to produce cold reduction tin plates commercially, in 1930, using for this purpose a four Stand, 32″ 4-High Tandem train furnished by the Mesta Machine Co. With the completion of the second 42″ 5-Stand 4-High Tandem, in 1937, the original mill has been dismantled and converted into one 2-Stand Tandem, and two single ‚Skin Pass Mills.

A comparison of the original 32″ 4-Stand Mill, and the newest 42″ 5-Stand Mill is of interest. The original mill had a total connected horse power of 940, and the newest mill of 4750, or more than five times as much. The speed of the original mill was 115 to 345 F.P.M., and of the latest mill 1152 to 1536 F.P.M., also about five times as great. See Table 17 below.

TENNESSEE COAL IRON & RAILROAD COMPANY

FAIRFIELD WORKS, FAIRFIELD, ALA.

Cold Reduction Tin Plate

The Tennessee Coal Iron & R. R. Co., early in 1938, completed and placed in operation, a fully equipped plant for the production of cold reduced tin plate. In addition to the 46″ 2-High Reversing Blooming Mill, and the 48″ Hot Strip Mill previously described, the plant includes:

Continuous Pickler, Two lines
Two 5-Stand 42″ 4-High Tandem Cold Mills
Four 2-Stand 42″ 4-High Temper Pass Mills
One Single 48″ 4-High Temper Pass Mill

Table 17 42″ 5-Stand 4-High Tandem No. 3

Stand	Type	Rolls Dia.		Lgth.	Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel							
1	Hor 4 Hi	18″	49″	42″	500	400/535	600	DC
2	Hor 4 Hi	18″	49″	42″	1000	600/800	600	DC
3	Hor 4 Hi	18″	49″	42″	1000	600/800	600	DC
4	Hor 4 Hi	18″	49″	42″	1000	600/800	600	DC
5	Hor 4 Hi	18″	49″	42″	1250	600/800	600	DC
	Tension Reel				150/225	225/900	600	DC

MOTOR-GENERATOR SET

Motor: 4820 KVA .8 PF 514 R.P.M. 4000 V 60 cy. syn.
Gen: 2—1750 KW 600 V DC 1—75 KW 250 V DC Exciter

The general characteristics of these mills, with their drives, is given in Tables 18-19-20.

In addition to the cold mills proper, there are:

Four Electro-cleaning lines

Thirty six Radiant Tube Annealing Furnaces with 108 Bases and Hoods

Eight Trimming and Shearing Lines, with gage classifiers

Two White Pickling units.

Twenty eight Hot Dip Tinning Pots.

Assorting Room

Warehouse and Shipping Room.

The rated annual capacity of the plant is 200 000 GT of finished tin plate.

TENNESSEE COAL IRON & RAILROAD CO.

FAIRFIELD WORKS, FAIRFIELD, ALA.

Table 18 42″ 5-Stand 4-High Tanden No. 1-2

		Rolls				Motors		
Stand	Type	Dia.	Lgth.	F.P.M.	H.P.	R.P.M.	Volt	Cur.
	Coil Box							
1	Hor 4 Hi	20″ 53″	42″		500	450/1050	600	DC
2	Hor 4 Hi	20″ 53″	42″		1250	350/790	600	DC
3	Hor 4 Hi	20″ 53″	42″		1250	350/790	600	DC
4	Hor 4 Hi	20″ 53″	42″		1250	350/790	600	DC
5	Hor 4 Hi	20″ 53″	42″	674/1565	1250	350/790	600	DC
	Tension Reel				250	300/1350	600	DC

MOTOR-GENERATOR SET

Motor: 7050 HP 1.0 PF 514 R.P.M. 6600 V 60 cy. syn.
Gen: 2—2500 KW 600 V DC 100 KW 250 V DC Exciter
1— 75 KW 200 V DC

Table 19 42″ 2-Stand Tandem Temper Pass No. 1-2-3-4

		Rolls				Motors		
Stand	Type	Dia.	Lgth.		H.P.	R.P.M.	Volt	Cur.
	Feed Reel			Drag Gen	2–50 KW	450/1200	225	DC
1	Hor 4 Hi	18″ 42½″	42″		200	600/1500	316	DC
2	Hor 4 Hi	18″ 42½″	42″		200	550/1250	316	DC
	Tension Dev.				200	550/1250	316	DC
	Reel				200	600/1500	316	DC

MOTOR-GENERATOR SET

Motor: 800 H.P. .95 PF 1200 R.P.M. 6600 V 60 cy. syn.
Gen: 400 KW 316 V DC Main 100 KW 250 V DC Booster
25 KW 250 V DC Exciter

TABLE 20 48″ SINGLE TEMPER PASS NO. 5

		Rolls			Motors			
Stand	Type	Dia.	Lgth.		H.P.	R.P.M.	Volt	Cur.
	Feed Reel			Drag Gen.	2–50 KW	450/1200	225	DC
1	Hor 4 Hi	18″ 49″	48″		300	400/1200	316	DC
	Tension Dev				300	400/1200	316	DC
	Reel				200	600/1500	316	DC

MOTOR-GENERATOR SET

Motor: 800 H.P. .95 PF 1200 R.P.M. 6600 V 60 cy. syn.
Gen: 400 KW 316 V DC Main 100 KW 250 V DC Booster
25 KW 250 V DC Exciter

CARNEGIE-ILLINOIS STEEL CORP'N.

IRVIN WORKS, DRAVOSBURG, PA.

Cold Reduction Tin Plate Mill

The Carnegie-Illinois Steel Corp'n., as a part of the Irvin Plant, for the production of hot and cold rolled flat steel products, completed and placed in operation, early in 1938 a cold reduction tin plate plant comprising the following:

One 42″ 5-Stand 4-High Tandem cold reduction mill
Two 42″ 2-Stand 4-High Temper Pass Mills
One 42″ Single 4-High Temper Pass Mill.

The characteristics of the above mills and drives is shown in Tables 21-22-23.

In addition to the cold mills proper, there are:
Three Electro-cleaning lines
Eleven radiant tube type annealing furnaces, with 36 bases having a capacity of 16 coils each.
Six flying shear lines, four of the reciprocating, and two of the rotary type. Each line is provided with a classifier for assorting the cut plates by gage.
Fourteen Hot Dip tinning pots
Assorting and Packing Room
Warehouse and Shipping Room.

CARNEGIE-ILLINOIS STEEL CORP'N.

IRVIN WORKS, DRAVOSBURG, PA.

Table 21 42″ 5-Stand Tandem

Stand	Type	Rolls Dia.		Lgth.	Motors H.P.	R.P.M.	Volt	Cur.
	Coil Box							
1	Hor 4 Hi	20½″	53″	42″	600	450/1050	600	DC
2	Hor 4 Hi	20½″	53″	42″	1500	350/790	600	DC
3	Hor 4 Hi	20½″	53″	42″	1500	350/790	600	DC
4	Hor 4 Hi	20½″	53″	42″	1500	350/790	600	DC
5	Hor 4 Hi	20½″	53″	42″	1500	350/790	600	DC
	Tension Reel				300	500/1200	600	DC

MOTOR-GENERATOR SET

Motor: 5400 KVA .95 PF 514 R.P.M. 6600 V 60 cy. syn.
Gen: 2—2500 KW 600 V DC 100 KW 250 V DC Exciter

Table 22 42″ Tandem Temper Pass Mills No. 1-2

Stand	Type	Rolls Dia.		Lgth.	F.P.M.	Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel					2–60 KW	610/1800	267	DC
1	Hor 4 Hi	18″	42½″	42″		200	670/1510	250	DC
2	Hor 4 Hi	18″	42½″	42″	600/1500	350	500/1250	250	DC
	Tension Dev.					350	500/1250	250	DC
	Reel					135	490/1450	250	DC

MOTOR-GENERATOR SET

Motor: 900 H.P. 1200 R.P.M. .95 PF 440 V 60 cy. syn.
Gen: 400 KW 250 V DC Main 100 KW 250 V DC Booster
25 KW 250 V DC Exciter

TABLE 23 42″ SINGLE TEMPER PASS MILL

Stand	Type	Rolls Dia.		Lgth.	Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel				2–60 KW	610/1800	267	DC
	Hor 4 Hi	18″	42½″	42″	350	500/1250	250	DC
	Tension Dev.				350	500/1250	250	DC
	Reel				135	490/1450	250	DC

MOTOR-GENERATOR SET

Motor: 900 H.P. 1200 R.P.M. .95 PF 440 V 60 cy. syn.
Gen: 400 KW 250 V DC Main 100 KW 250 V DC Booster
25 KW 250 V DC Exciter

YOUNGSTOWN SHEET & TUBE COMPANY

INDIANA HARBOR WORKS, INDIANA HARBOR, IND.

Cold Reduction Tin Plate

Supplementing the 54″ Hot Strip Mill, previously mentioned, the Youngstown Sheet & Tube has placed orders for a 48″ 5-Stand Tandem Cold Strip Mill, for the production of strip for tinning, that in connected horse power, speed, and rated capacity, will exceed any of the mills for the purpose, now in operation. The new Tandem Mill will be additional to the two single stand reversing strip mills, now in operation at the Indiana Harbor Plant.

Last year this company completed the installation of a 42″ 2-Stand Tandem Skin Pass Mill, supplementing the Single skin pass mill previously in operation. This mill is unique, in its type, in that the driving motors, and the drag generators, are all direct connected, no gear reduction units being employed.

The characteristics of these two mills, and their drives, are shown in Tables 24-25.

FOREIGN CONSTRUCTION

NIPPON STEEL CO.

YAWATA, JAPAN

Supplementing the Hot Broad Strip Mill, now under construction, in the United States, this company has placed with the Mesta Machine Co. an order for a five stand, 4 High Tandem Cold Strip Mill, and for two single 4 High, Skin Pass Mills, for the production of cold reduced tin plate, with an estimated annual capacity of 180 000 tons.

There has also been ordered by the above, and by associated companies considerable other rolling mill equipment including: One 16½″ and 49″ x 42″ four high reversing, cold strip mill, driven by 1—1750 H.P. 400/600 R.P.M. and 2—500 H.P. 250/875 R.P.M. 600 V, DC, Motors. One 66″ 3 High Hot Sheet Mill with 750 H.P., 500 R.P.M. 3300 V, 50 cy A.C. motor, and one 66″ four high cold sheet mill, with 1000 H.P., 500 R.P.M., 3300 V, 50 cy motor. One 44″–56″ 4 High Cold Strip mill, with 1—1000 H.P. 500/800 R.P.M. and 1—200 H.P. 300/1200 R.P.M. 600 V, DC motors. One 32″ 4 High Cold strip mill, with 800 H.P. 300/800 R.P.M. and 1—200 H.P. 300/1200 R.P.M. 600 V, DC motors.

NARROW STRIP MILLS

There has been little activity in the construction of new mills for the production of strip in narrow widths during the period covered by this paper. This is presumably to be explained by the greater efficiency of the wider mills, and economies incident to the rolling of the wider widths, and then slitting to narrower widths. Such mills as have been installed have been of 24″ to 38″ roll face, and have been almost exclusively of the single stand reversing type.

Table 24 48″ 5-Stand Tandem Cold Mill

Stand	Type	Rolls Dia.		Lgth.		Motor H.P.	R.P.M.	Volt	Cur.
	Coil Box								
1	Hor 4 Hi	18″	49″	48″		1500	300/600	600	DC
2	Hor 4 Hi	18″	49″	48″		1750	300/600	600	DC
3	Hor 4 Hi	18″	49″	48″		1750	300/600	600	DC
4	Hor 4 Hi	18″	49″	48″		1750	300/600	600	DC
5	Hor 4 Hi	18″	49″	48″	940/1880	1750	175/350	600	DC
	Tension Reel					400	300/1200	600	DC

MOTOR-GENERATOR SET

Motor 6000 HP 1.0 PF 514 R.P.M. 11000 V 60 cy. syn.
Gen: 2—2500 KW 600 V DC

TABLE 25 42″ 2-STAND TANDEM SKIN PASS MILL

Stand	Type	Rolls Dia.		Lgth.		Motors H.P.	R.P.M.	Volt	Cur.
	Feed Reel					2–25 KW	90/360	125	DC
	Tension Dev.					150 KW	215/430	250	DC
1	Hor 4 Hi	18″	49″	42″		350	215/430	250	DC
2	Hor 4 Hi	18″	49″	42″	1013/2026	350	215/430	250	DC
	Tension Dev.					350	215/430	250	DC
	Reel					150	95/380	250	DC

MOTOR-GENERATOR SET

Gen: 1000 KW 250 V DC

AMERICAN STEEL & WIRE CO.

CUYAHOGA WORKS, CLEVELAND, O.

Cold Strip Mill

During 1937, approximately $4 000 000 was appropriated for the re-arrangement and improvement of the cold rolling facilities at the Cuyahoga Works of the American Steel and Wire Co.

The present strip cleaning and storage departments have been centralized and improved, the buildings having been extended by two additions having a combined length of 188 feet, together with crane runways and cranes.

The addition of new cold rolling mill equipment is under way. New slitting equipment will be added allowing more efficient operation on the wider coils of strip which are now obtainable both from the McDonald Works, and from the Gary Works, of the Carnegie-Illinois Steel Corp'n.

The annealing department has been improved by the addition of Bell Type Annealing Furnaces for coiled strip, and improvements in the existing equipment. Two new Box Annealing furnaces, and one continuous electric annealing furnace, with pay off reels, take up frame, and D X gas generating unit have been added.

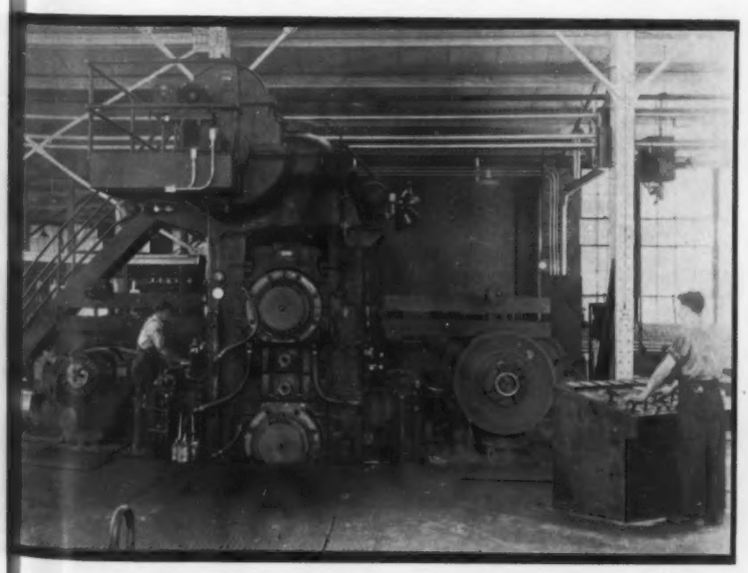
ACME STEEL COMPANY

RIVERSIDE, ILLINOIS

The Acme Steel Company added, in 1937, a new four high reversing mill, with rolls 14″ and 35″ x 29″, and driven by a 1000 H.P., 500/1000 R.P.M., 600 V, DC. motor, on the rolls and 2—200 H.P. 300/1200 R.P.M., 600 V, DC. motors, on the reels.

This mill is so typical of the present trend, in the rolling of strip, as distinguished from sheet width material, that the illustration, below is of interest.

New four-high reversing mill, Acme Steel Company, Riverside, Illinois.



THOMAS STEEL COMPANY
WARREN, OHIO

The Thomas Steel Company has purchased one, single stand, 10″ and 26″ x 24″ four high reversing mill, driven by a 600 H.P. 600/960 R.P.M. 250 V. DC, motor, on the rolls and 2—150 H.P. 350/1350 R.P.M. 250 V. DC. motor on the reels.

McLOUTH STEEL COMPANY
DETROIT, MICH.

The McLouth Steel Company, Detroit, Michigan, has installed one single stand, 10″ and 26″ x 24″ four high reversing mill, driven by a 600 H.P. 600/960 R.P.M. 250 V. DC. Motor, on the rolls and 2—150 H.P. 350/1350 R.P.M. 250 V. DC. on the reels.

SUPERIOR STEEL CORP'N.
CARNEGIE, PA.

The Superior Steel Corp'n., has installed one new 4-High cold strip mill of 30″ face. This will increase

Two stand tandem skin pass mill, delivery side, Youngstown Sheet & Tube Company, Indiana Harbor, Indiana.

the maximum width rolled by this company from about 20″ to about 30″. The mills will be used both for carbon steel grades and for stainless steel.

The new mill has been located in the building formerly occupied by the 12″ Hot Strip Mill, which was recently dismantled.

GREER STEEL CO.
ANDERSON, IND.

The Greer Steel Co., has added a 16″ and 34″ x 38″ four high cold strip mill, at the Anderson Plant, driven by a 400 H.P., 300/900 R.P.M., 250 V, DC, Motor.

THREE HIGH SHEET MILLS

There is one other development, in the field of flat rolling, that may not be passed by without comment. This is the greatly extended use of the three high water mill, for the rolling of sheets and black plate, and particularly for the roughing down of sheet and tin bars, finishing on the conventional hand, or mechanized, two high mills.

The three high roughing mills are of two types, the jump rougher, with hand operated screw down, and the balanced rougher, with electric screw down, and preset pass adjustment for either 3-5- or 7 passes.

During the years of 1937 and 1938, there were approximately twenty of these mills sold, for use in the United States and in Foreign countries. There are now in use a total of about fifty of these mills in all.

Among the three high roughing mills installed in the United States during 1937 and 1938, may be mentioned:

Columbia Steel Co., (U. S. Steel Subs.) Torrance, Cal.
One stand three-high, jump rougher, with continuous furnace, and automatic tables. Two existing sheet mills are being equipped with continuous pack furnaces and automatic feeder and catcher tables, and one hand mill with continuous pack furnace.

Continental Steel Corp., Kokomo, Indiana.
One stand three-high balanced rougher, with continuous pair furnace, automatic tables, and electric screwdown.

Continental Steel Corporation, Canton, Ohio.
One stand three high jump rougher, with continuous pair furnace, and automatic tables.

Empire Sheet & Tin Plate Company, Mansfield, Ohio
One stand three high jump rougher, with continuous pair furnace, and automatic tables.

Reeves Manufacturing Company, Dover, Ohio.
One stand three high jump rougher, with continuous pair furnace, and automatic tables.

There have been a number of three high mills built for use abroad, during the past several years, including two each for Great Britain, U.S.S.R. (Tin plate roughers), India, Australia, and Japan, and one mill each for Canada, and for Sweden.

THREE HIGH FINISHING MILLS

While by far the greater number of the three high mills have been installed for the purpose of roughing down sheet and tin bars, to be finished on the conventional hand, or mechanized, two high mills, there have been a few constructed for the finish rolling of sheets, in gages, of No. 22 and heavier.

The American Rolling Mill Co., in 1930, installed two at the Ashland Plant, which are used for finishing auto-body, metal furniture, and enameling sheets, from breakdowns produced on the continuous sheet mill.

The American Sheet & Tin Plate Co., (now Carnegie-Illinois Steel Corp'n.) from 1932 to 1934, installed several three high finishing mills, at the Vandergrift Works, and at the Gary Sheet Mill. They also installed, in 1937, one at the Wood Works, McKeesport, Pa., to be used especially for the finish rolling of stainless steel sheets.

CONVENTIONAL SHEET MILLS

Some twelve years ago, with the appearance of the Continuous Sheet Mill, and the Broad Strip Mill, the ultimate disappearance of the conventional hot sheet mill, was gravely prophesied, but in 1938 there are still numbers of them in operation, some modernized by the addition of three high roughing stands, and some by the addition of continuous pair and pack furnaces, and automatic feeder and catcher tables, and others still using the conventional hand methods. This is true not only as regards those companies who have no other means of producing sheets, but also to some extent, for those companies who have Hot Broad Strip Mills. In 1937, with the demand for sheets in the second and third quarters, we find the peculiar condition of old style sheet mills, already marked for dismantling, being reconditioned and placed in operation.

ROLL BEARINGS

The most conspicuous feature in the design of the more recent Broad Strip Mills, both hot and cold, has been the almost exclusive use of bearings of the oil sleeve type, instead of roller bearings, on the backing rolls. The use of the roller type bearings on the working rolls, however, is still universal.

Following the experimental installations of sleeve type bearings, at the Inland Steel Co., and Wheeling Steel Co., plants, the first hot broad strip mill to be equipped throughout with bearings of the oil sleeve type was the 79″ Mill of the Youngstown Sheet & Tube Co., at the Campbell Works, in 1934, and this was followed, in the next year, by the 79″ Mill of the Bethlehem Steel Co., at Lackawanna, N. Y. The bearings in both these mills were furnished by the Mesta Machine Co.

The next hot strip mill to be built, the 80″ Gary Sheet Mill, was equipped with roller bearings on the four high stands, with the exception of the Broadsiding stand, which was equipped with composition bearings of the phenolic resin type. In the Granite City Steel Co., 90″ Mill, which was under construction at the same time, oil sleeve bearings of the Morgoil type were used.

All of the succeeding mills, with the single exception of the 100″ Homestead Mill, have been equipped with oil sleeve bearings, either of the Mesta, or of the Morgoil type.

The first instance of which I find any record, of the application of the oil sleeve bearing, to a wide four high cold mill, is that of the 58″ Cold Strip Mill, at the Ashland Plant of The American Rolling Mill Co., a

single stand being equipped with Morgoil bearings, early in 1933.

In 1934 the Mesta Machine Co., built a five stand, 42″ Tandem Mill equipped with oil sleeve bearings for the Wheeling Steel Corp'n., Yorkville, O. Following this installation all of the four high cold mills of the Youngstown Sheet & Tube Co., and of the Bethlehem Steel Co., were furnished similarly equipped.

In 1935 The American Rolling Mill Co. installed the three stand, 80″ Tandem Cold Strip Mill, at the Middletown Plant, and this was equipped throughout with bearings of the Morgoil type, and in that year, and the next, 84″ and 72″ Cold Strip Mills of the Gary Sheet Mills, were equipped with sleeve bearings, of this same type.

Since 1935, substantially all of the Cold Broad Strip Mills built, with the exception of some skin rolling mills, have been equipped with oil sleeve bearings either of the Mesta, or the Morgoil type.

NON-METALLIC BEARINGS

The use of non-metallic bearings, of the phenolic resin type, has been greatly extended during the past two years. Two applications, in particular, are of special interest in Broad Strip rolling. These are the use of non-metallic bearings on the back-up rolls of the broadsiding stand of the 80″ Hot Strip Mill, at the Gary Sheet Mill, of the Carnegie-Illinois Steel Corp'n., and on the back-up rolls of the 4-High Steckel Hot Mill, at the Indiana Harbor Plant of the Youngstown Sheet & Tube Co. These constitute the first incursions into this field, in which the roller bearing was first supreme, and later ousted from this position by the oil sleeve type, and the results obtained in these two installations indicate a probable further extension into this field.

The use of non-metallic bearings on the top and bottom rolls of the three high sheet mills, is practically universal, and is common on other types of mills, ranging from 10″ wire rod mills, to 44″ Blooming Mills.

Wherever the application of this type of bearing is practicable, this generally meaning the availability of a plentiful supply of pure clean water, they have made a favorable showing as compared with bearings of any other type.

AUXILIARY OPERATIONS

In addition to the rolling proper, there are numerous auxiliary operations, in the processing of sheet and strip, both hot and cold, that play an important part in the question of whether wholly, or only partially successful operation is attained.

Among these auxiliary operations, may be mentioned: Slab heating, and with it the control of combustion, lubrication, continuous pickling, the welding of strip lengths, annealing, electro-cleaning of strip for tinning, side trimming, shearing and leveling, and finally the handling of process and finished material.

These finishing and auxiliary operations, are equally worthy of consideration with the main operation of rolling. The program of papers, presented before this Association, during the past two years, however, is so well rounded out, by the inclusion of papers covering many of these subjects specifically, by authorities on their particular subject, that any detailed consideration of them, in the present paper would be superfluous.

PRODUCTION

In concluding this paper, it may be an appropriate time to consider briefly the productive capacity of the Broad Strip Mill, and its relation to the total production, of finished rolled steel in the United States.

Table 26 gives, for each year from 1926 to 1937, inclusive, the number of Continuous Sheet, and Hot Broad Strip Mills, in operation; their estimated production; the total production of finished rolled steel; and the per cent of continuous rolled sheets, and hot broad strip, to the total finished rolled steel. As is shown by the figures, the percentage of the total, produced by these two types of mill, increased from about 1½%, in 1927, to over 25%, in 1937.

Figures for the year 1938 are not yet available but, as is known to all of you, the last three months of 1937 saw an unprecedented fall in steel demand, in common with commodities generally, and this carried over into the first half of 1938, with the result that the production for last year will probably not exceed 55% of that of 1937.

TABLE 26
HOT BROAD STRIP AND CONTINUOUS SHEET MILLS

Year	Number in Operation	Estimated Production N. T.	Production Finished Rolled Steel G.T.	Per Cent
1926	1	250 000	34 819 038	.6
1927	5	550 000	32 334 687	1.5
1928	6	1 250 000	37 177 939	3.1
1929	7	1 740 000	40 594 367	3.8
1930	8	1 570 000	29 196 954	4.8
1931	9	1 540 000	18 987 168	7.2
1932	12	1 550 000	10 352 376	13.4
1933	12	2 900 000	16 604 433	15.6
1934	12	3 400 000	18 807 366	16.2
1935	16	5 200 000	23 830 061	19.5
1936	20	8 300 000	33 599 510	22.1
1937	24	10 500 000	36 604 032	25.6
1938	27	.....	.....	....

The great increase in production of the Continuous Sheet and Broad Strip Mill, from 1927 to 1937 was not only due to the increase in the number of mills in operation, but also to the increased production of the individual mills. Thus the five mills in operation in 1928 averaged 249,000 tons per year, while the same five mills, in 1937, averaged about 480,000 tons each.

Equally impressive with the figures for total tonnage are the eight hour and monthly records. In 1927, when this type of mill was in its infancy, 400 net tons per shift, or 25,000 tons per month, was considered excellent practice. In August, 1937, the Great Lakes Steel Company's 96″ mill made 1885 net tons in an eight hour shift. In the same month, the Lackawanna Mill rolled 101,300 net tons. Both of these, as far as has been published, are all-time records.

A NEW *Process for* TREATING *Waste from* STEEL *Pickling* PLANTS

By DR. M. J. RENTSCHLER

DIRECTOR OF RESEARCH

ALLIED DEVELOPMENT CORP.

CLEVELAND, OHIO

Presented before the
A. I. & S. E.
Pittsburgh District Section,
December 20, 1938

▲ THIS occasion does not call for a discussion of the history of waste pickle liquor disposition. The problem has always been a favorite football with steel executives, state legislators, sanitary experts and consulting chemists. You know the difficulties of the problem and you know the seriousness of it. Most of you have served on committees to determine "What shall we do with our pickle liquor?" You also know the scope of the problem. A rough estimate indicates that our industry is discharging a million gallons per day of waste pickle into public water ways, old coal mining shafts, drainage ditches, and innumerable hidden dumps. Inevitably the evil effects of acid, iron salts, and corrosion come to light and punishment in the form of injunctions, damage suits, and government persecutions are piled upon us.

Lime is unloaded directly from cars and conveyed by elevator conveyors to the storage.

The steel industry has been thoroughly alert to this evil and millions have been spent in our efforts to cure or, at least, to mitigate the harmful effects of steel plant waste. Unfortunately, however, the quantity of waste pickle liquor is increasing from day to day and the advent of the continuous strip pickling operation not only increases the volume but also the acidity of the liquor while the use of hydrofluoric, nitric, and hydrochloric acids in the pickling of stainless and alloy steels adds to the intensity and difficulty of the waste pickle liquor problem.

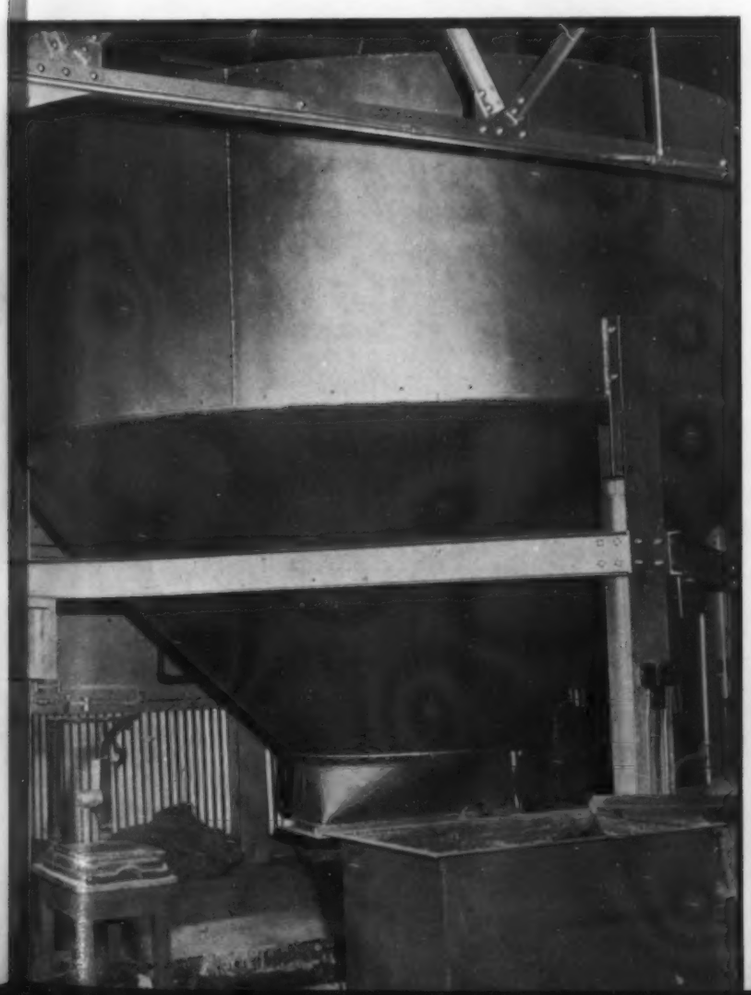
The modern trend of steel mill operation leans entirely towards speed and low cost production. The strip mill has been found to be the answer. In the old type of hand mills the batch picklers were able to keep up with production very easily and the acid tanks could be run down as low as 1 per cent acid without much trouble, but in the new strip mills the steel is rolled out so fast that the delivery speed of the picklers must be correspondingly fast to keep the mill supplied. The delivery speed on some strip picklers runs in the neighborhood of 110 to 150 feet a minute where four acid tanks, 60 ft. each, are used. To maintain this rate of pickling, the acid content must be kept high. As the iron in solution increases in the pickling tanks, the pickling speed will decrease unless the loss in activity is counteracted by the addition of acid or temperature increase. You all know that there are practical limits to which this can be done. It appears that for average conditions

Dr. M. J. Rentschler inspecting the basic product of the process.

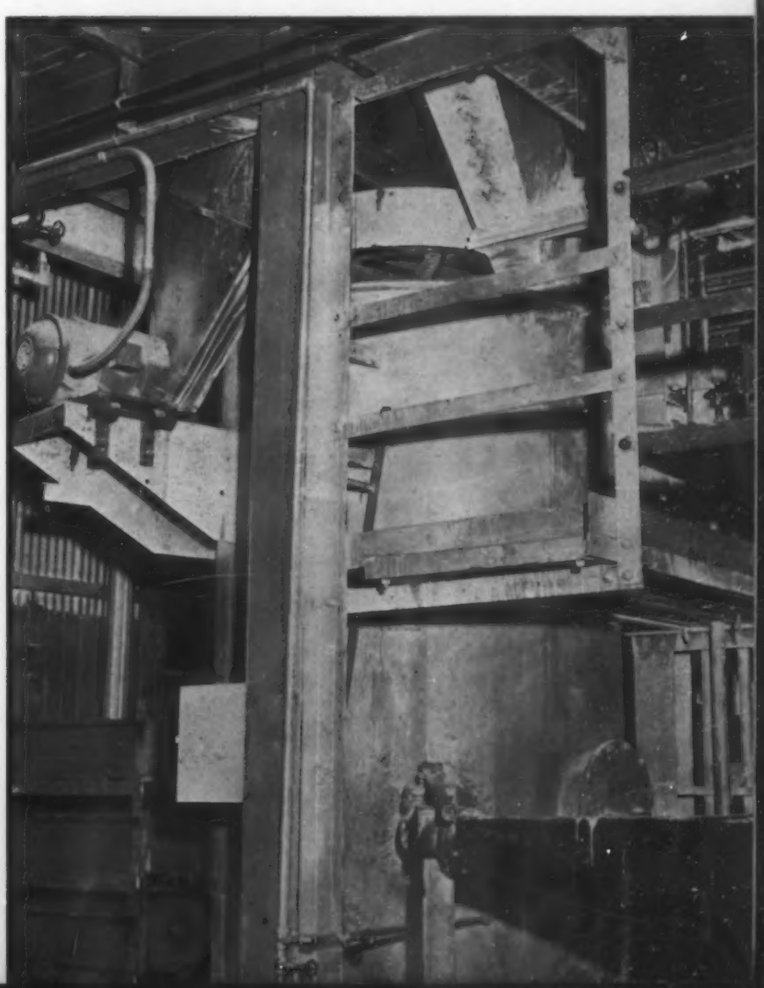
in a strip pickler it does not pay to run the tanks over 20 to 25 per cent ferrous sulphate content or lower than a 4 to 6 per cent acid content. To run the tanks high in iron and low in acid would mean a reduction in pickling speed that would immediately slow up the production of properly pickled strip, and throw out the operating balance of the mill. All these conditions tempt us to discard our pickling solutions when still highly acid.

State and national authorities insist that a process for the disposition of waste pickle liquor must not only yield a sanitary and harmless effluent, but such effluent must not effect important public operations as the chlorination and filtration of water supplies used for drinking purposes. The public, as well as the steel industry profits by an effluent that is free from corrosive action and contains no salts, such as those of magnesium, which on hydrolysis produce corrosive products ruinous to boilers, pipe lines, open hearth ends, etc. In other words, the effluent should increase the hydrogen-ion concentration of the stream into which it is discharged rather than decrease it. Only when the effluent from a pickle liquor plant meets these requirements can the process be called satisfactory. In the words of the Health Commissioner of Pennsylvania: "The effluent, when discharged into the waters of the Commonwealth, shall not be injurious to the public health or to animal or aquatic life, or prevent the use

The overhead lime storage feeds the desired quantity directly into the lime mixing tank.



In the mixing tanks, crushed rock quick lime is slaked with water, and the milk of lime agitated.



of the water for domestic, industrial, or recreational purposes."

When this pickle liquor problem was presented to us a year or so ago we began our work by making a careful study of the volume of liquor discharged, the variations in the composition of the liquors from the same and different plants as well as the processes suggested and operated heretofore for the solution of the problem. It became apparent at once that the enormous volume of liquors discharged and the costs of handling them would preclude a satisfactory general solution of this nuisance problem by any of the known processes. Knowing also that the normal ingredients of pickle liquor, even when isolated in pure form have all very limited commercial application or value, we decided to view the problem from a new angle; namely, could not the ingredients of pickle liquor be considered as an intermediate raw material and new articles of utility manufactured from them?

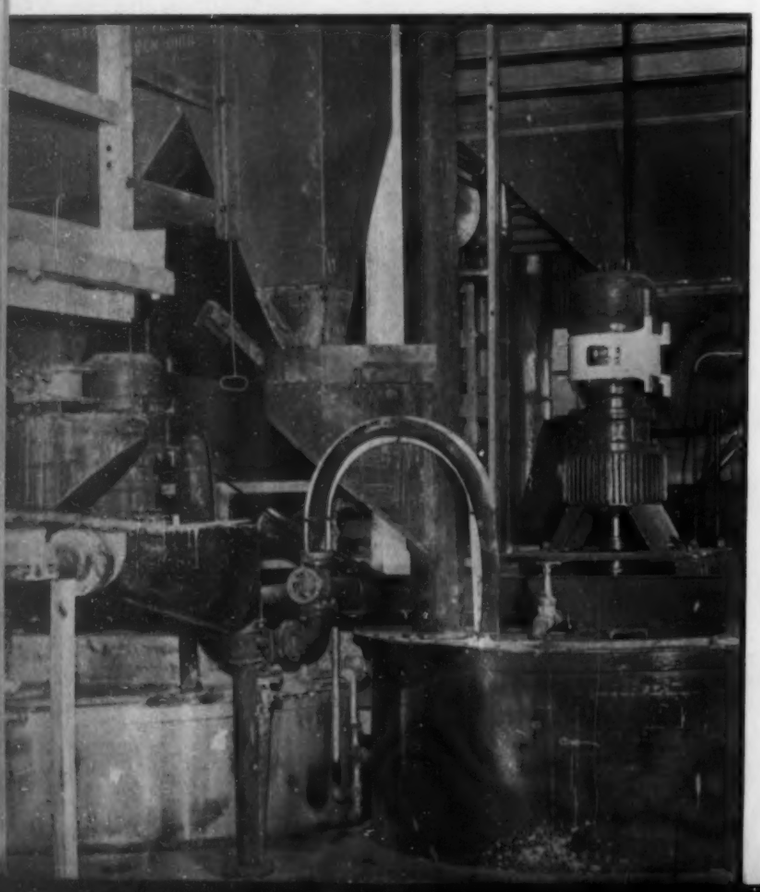
In view of the high cost of building materials, the need for insulation in the development of modern steel housing, refrigeration and storage plants and general air conditioning work, we adopted the aim of producing low cost serviceable materials in these construction fields. Preliminary laboratory investigations indicated that a material possessing unusual structural strength excellent insulating qualities and resistance to high temperatures could easily be produced from pickle liquor. We designated the base material Ferron and soon found that its physical properties could be controlled by varying the methods of operation and the addition of a variety of organic and inorganic fillers. We, therefore, designed and built a pilot plant with a capacity of several tons per day, and we have succeeded in producing very creditable specimens of materials of construction. Among these we list insulating and fire-proof wall boards; high temperature insulating brick and plaster; fire-proof building blocks and bricks possessing excellent insulating and acoustic properties; pipe covering; finishing plaster; plastic and granulated Ferron, the latter of proven value in removing sulphuretted hydrogen from manufactured gas. Articles made from Ferron cannot burn, decay or scum. The material is proof against termites and can readily be water proofed. It is easily sawed, cut, drilled, planed, and grooved without marked dulling of the tools. Nails, screws, and staples hold firmly in the product and both rough and finishing plaster can be readily applied on the same day without fear of cracking, thus avoiding construction delays. It is non-corrosive and can be painted, shellacked or varnished to any color or finish desired. It has been found that all cementing materials work well with Ferron.

It has been pointed out by a number of commentators and steel men that the tonnage of Ferron produced in this manner, should all the pickle liquor be so treated, would be enormous. There is no disputing this fact but you will doubtless be interested to know that the entire amount could be absorbed in the building materials trade with very little difficulty. The consumption of hard plaster wall board for the year 1929, according to Government figures, was over 750,000 tons. This is over 2,000 tons a day and with an improved product such as we have been able to produce, this quantity could be considerably extended. The manufacture of hollow tile, building block, and other products take equally large tonnages. It is our estimate that there is a field for between 5,000 and 10,000 tons per day of Ferron which, I believe, will satisfy any of you as to what the outlet possibilities for this product are.

The Sharon Steel Corporation was the first steel company to obtain a license to use the process and the plant at Sharon is now operating to the entire satisfaction of the management of the Sharon Steel Corporation. The material produced at the Sharon plant has been shipped in carloads and trucks to a number of consumers for boiler insulation, house construction, and general insulation work with very gratifying results.

The plant at Sharon embodies all the essential features of our process but due to the small size of the plant and the fact that it was the initial installation certain labor saving devices were not incorporated in it. The pickle liquor is stored in a large reservoir which holds several days' supply. From this tank it is pumped into small agitating tanks containing about 2,000 gallons. The chief ingredient used in the process outside of pickle liquor is calcium hydroxide or as it is more commonly known, milk of lime. The lime is brought into the plant in the form of crushed rock quick lime and stored in an overhead steel bin. From here the lime is dropped by gravity into a 1500 gallon mixing tank where it is slaked with water. To the pickle liquor, which has been added to the mixing tank, a small amount of fibre in the form of ground-up newsprint or other waste paper is added and the solution is diluted to where the iron sulphate is approximately 5 per cent and the acid content is about 2 per cent. This dilution step is necessary in order to insure a satisfactory reaction but in cases where large amounts of wash water

In the neutralization tank, milk of lime is mixed with pickle liquor and agitated until acid is neutralized and iron precipitated.



need to be handled, the dilution can be carried much further without any adverse results. This point is of considerable interest, I believe, since a great many plants have large amounts of acid wash water and in the future this may be the subject of legislation as well as the pickle liquor. Our system will handle any amount of wash water.

The milk of lime is now added to the tank while it is being agitated until the acid is completely neutralized and the iron is entirely precipitated as iron hydroxide. The completion of this reaction is indicated by a sharp rise in the pH of the solution and is determined practically by dropping a small amount of the slurry onto a piece of paper moistened with phenolphthalein. When the reaction is complete, the paper turns a bright red which can easily be discerned by the operator.

The material in the tank is of the consistency and general appearance of split pea soup and is now pumped to pressure filter presses by a plunger type pump. The material, while filtering very readily, requires considerable pressure to reduce the moisture to the desired point of approximately 50 per cent. It leaves a press cake of considerable firmness. These presses are then opened and the cake dropped into a pug or auger mill which is an apparatus used in the clay working industry. This mill pugs the press cakes into a uniform mass and then extrudes it in a continuous block form. The block is extruded onto plates on a tray and the cakes are continuously cut off as they fill the pans. These trays are now racked three deep onto a car and run into a tunnel drier where the moisture is removed and the material sets and oxidizes at the same time. Evaporation of the 50 per cent water produces a highly porous product.

It will doubtless be of interest to you to see the method of calculating the amount of lime used in this process. Theoretically the reaction can be written as follows:

$$FeSO_4 : 7H_2O + CaO \rightarrow Fe(OH)_2 + CaSO_4 + 6H_2O$$
$$277.0092 \quad 56.08$$

2000 x 26/100 x 56.08/277.0092 x 96/100 = 101.6 pounds lime 96 per cent.

$$H_2SO_4 + CaO \rightarrow CaSO_4 + H_2O$$
$$98.0756 \quad 56.08$$

2000 x 6/100 x 56.08/98.0756 x 96/100 = 64.8 pounds lime 96 per cent.

Total lime required for one ton of pickle liquor containing 26 per cent iron sulphate and 6 per cent acid is 101.6 for the iron and 64.8 for the sulphuric acid or 166.4 total 96 per cent lime. This is equal to 8.32 per cent of 96 per cent lime based on pickle liquor of the analysis given above.

In looking over the operations at Sharon we find that on the same basis the plant used 8.62 per cent of lime covering one month's operations.

We have developed an interesting and quick method of determining the strength of pickle liquor based on the theoretical formula I have just given you:

The number of strength units of any pickle liquor or the amount of Ferron in pounds that 10 gallons of this pickle liquor will make equals the per cent acid by weight times 1.75 plus the per cent iron by weight times 5.

Therefore, in order for any of you to determine the number of pounds of material that can be made from your pickle liquor, all you need to do is to apply this formula.

To go back to our pickle liquor containing 26 per cent $FeSO_4 \times 7H_2O$ and 6 per cent H_2SO_4, we have in this liquor 5.3 per cent iron and 6 per cent acid. Applying the formula we get 6 per cent x 1.75 or 10½ plus 5.3 x 5 equals 26½ or a total of 37 strength units or 37 pounds of Ferron from 10 gallons of pickle liquor. The example we have given here is a slightly weaker pickle liquor than the average we have seen.

All of you gentlemen will be very much interested in the cost of operating this process and the resultant cost of the product. From the information we have obtained from various steel companies it is our sincere belief that this process of disposing of waste pickle liquor is as economical as any other process considered to date, allowing no value for the product. Please remember that the initial plant at Sharon was built without any experience. For this reason it was felt desirable to limit the capital cost and not include continuous automatic precipitators, continuous automatic driers and other similar labor saving devices which a new plant would now undoubtedly incorporate. Furthermore, batch operation being more flexible was desirable since we had no past large scale experience to guide us which has now been obtained from this first plant.

Now in regard to costs, the chief expense is that of lime. One ton of quick lime will produce slightly over five tons of dry Ferron. The quick lime for our process is being bought at less than $8 per ton delivered so that the cost of this item is roughly $1.60 per ton of finished product. The other large item is the cost of drying which naturally depends on the fuel used. The cost

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A reciprocating pump serves to move slurry formed in the process from the neutralization tank to the filter press.

of drying by gas is roughly 80 cents per ton while if coal were used, this cost could be reduced somewhat and would be in the neighborhood of 55 cents per ton. The possibility of using waste heat is not out of the question.

Another large item in cost is that of labor which to date at Sharon has been rather high due to the fact, as I previously stated, that this process is entirely new and it was necessary for us to start on an experimental basis. I am very glad to say that the labor costs at Sharon are continually dropping. For a larger size plant which we have under consideration it is estimated that the labor cost will be either $1.40 per ton or 70 cents per ton depending on which type of equipment is used. The cost of electric power is estimated at 16 cents per ton and the cost of repairs and miscellaneous materials at 24 cents per ton. Adding up these figures we get a total cost of $3.15 to $4.20 per ton of material produced which represents the disposal of 500 gallons of pickle liquor.

The following is a table giving "K"—the number of Btu. per hour, per square foot, per inch thickness per degrees F., for various building materials. The samples of Ferron used for test were one of the first lots made and do not necessarily represent the ultimate in insulating properties that can be obtained from this new material.

Material	K.
Ferron	.55
Asbestos sheets	1.05
Building brick work	4.80
Fire clay brick	8.40
Asphalt	5.16
Plaster	3.00
Gypsum (Formed)	3.00
Cork	.30
Diatomaceous earth pipe covering	.61
85 per cent magnesia covering	.47
Paper	.80
Powdered magnesia	4.20
Concrete	5.28
Light wt. cinder concrete	2.40
Rubber	1.08
White pine wood	1.04

Ferron can be used for temperatures up to 900 degrees F., and mixed with clay can be used up to 2000 degrees F. All the organic insulators such as cork, wood, etc., fail at 300 degrees, 85 per cent magnesia fails at 600 degrees F., plaster and gypsum fail at 300 degrees F.

One inch of Ferron brick will insulate as well as nine inches of building brick.

One inch of Ferron plaster will insulate as well as 5½ inches of building plaster.

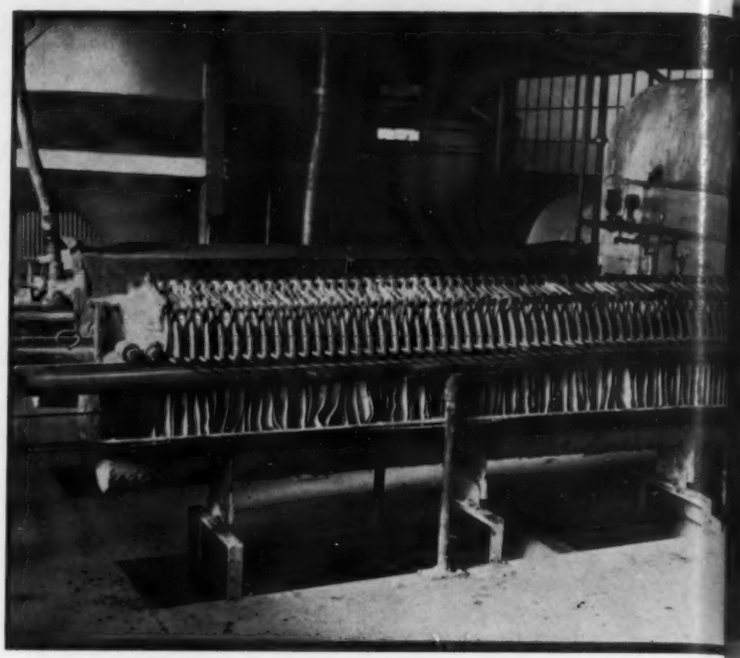
One inch of Ferron wall board will insulate as well as 5½ inches of gypsum sheet rock board.

One inch of Ferron board will insulate as well as 2 inches of wood.

This data will give you an idea of the value of the solids recovered from the process; now as to the effluent.

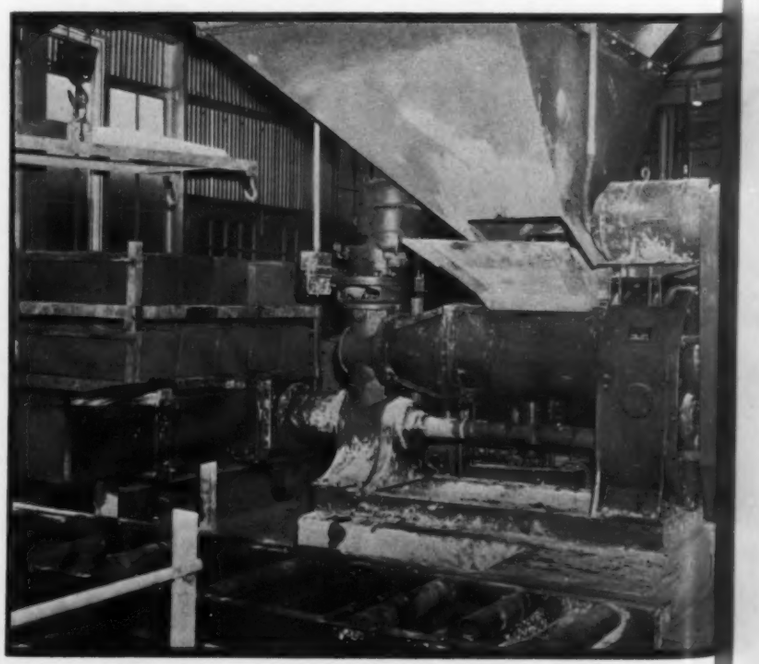
Creig Hoyt, Professor of Inorganic and Physical Chemistry at Grove City College, has made a careful chemical and bacteriological study of the effluent from the plant at Sharon. Under date of October 12, 1938, Professor Hoyt writes:

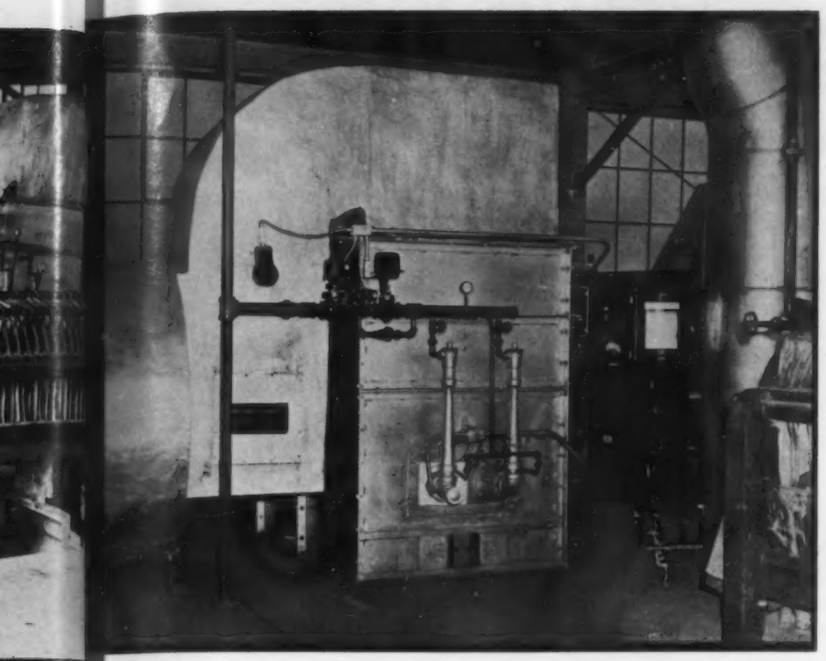
"Enclosed is a report of the chemical and bacteriological analysis of the sample of the filtrate



In the filter press, pressure is applied to reduce moisture to the desired point of about 50 per cent.

Press cakes from the filter press are dropped into a pug mill, where they are made into a uniform mass and extruded in block form.





Air for circulation through the tunnel drier is heated in a gas-fired air heater.

from the recovery process for waste pickle liquor taken October 4, 1938.

This shows complete removal of iron, silica, and all heavy metals. The pH is quite high and it is this high pH which no doubt accounts for the almost complete removal of magnesia as well as the heavy metals. This suggests that the use of high magnesia lime for the process is not economical in spite of the greater neutralizing power per lb., because it is eventually reprecipitated by lime as insoluble magnesium hydroxide, even if it were responsible for earlier neutralization. This merely adds to the expense and the bulk of the precipitate. I am, of course, ignoring the possibility of its usefulness in improving the insulating properties of the precipitate.

So far as the sanitary quality of this effluent is concerned, it is altogether acceptable. It has undergone excess lime sterilization at a high temperature, and has no bacterial content whatever. It does not have any oxygen absorbing capacity and contains no compounds not now present as normal constituents of the stream. These are, in order of amount, calcium hydroxide, calcium sulphate and sodium chloride. Whereas the former effluent decreased the pH of the stream, this increases it. I should consider this effluent as entirely suitable for discharge to the stream."

(Signed) CREIG S. HOYT.

Under date of August 23, 1938 the Sanitary Water Board of the State of Pennsylvania approved the process now in operation at Sharon as a satisfactory method for the disposal of pickle liquor.

In this new development we have found a very receptive attitude of co-operation from the steel industry in general. Naturally they wish to dispose of their waste pickle liquor in a satisfactory manner but at as low a cost as possible.

In closing, we want to express our appreciation to the many members of this organization for their co-operation with us in this work. There is no doubt in our minds that the millions of gallons of pickle liquor which daily discharge into and contaminate the pure waters of our country can easily be converted into valuable products which constitute necessities in our modern, economic life.

DISCUSSION

PRESENTED BY

W. M. EDWARDS, Chief Chemist, Republic Steel Corporation, Warren, Ohio.

W. W. HODGE, Industrial Fellowship, Mellon Institute, Pittsburgh, Pa.

W. E. STEINER, Chief Chemist, Bethlehem Steel Company, Johnstown, Pennsylvania.

GENE LA SCHOBER, JR., Metallurgical Assistant, Bethlehem Steel Company, Sparrows Point, Maryland.

M. J. RENTSCHLER, Director of Research, Allied Development Corporation, Cleveland, Ohio.

T. G. TIMBY, Chemist, McKeesport Tinplate Company, McKeesport, Pennsylvania.

MAX HARTENHEIM, Electrical Engineer, Jones & Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

G. S. WARREN, Chief Engineer, Sharon Steel Corporation, Sharon Pennsylvania.

R. J. WEAN, President, Wean Engineering Company, Inc., Warren, Ohio.

W. R. KERR, Ceramic Engineer, Armstrong Cork Company, Beaver Falls, Pennsylvania.

W. M. EDWARDS: Disposal of pickle liquor, among steel men, has been an ever-present topic and until recently has been discussed along with the weather, and with about the same results. However, there is no longer any doubt that something has to be done and Dr. Rentschler's proposal is a long step in the right direction. Very much in favor of the Ferron process is the fact that the final product may be easily handled and also that it has a potential value which may develop into a valuable by-product. In the latter case, this would be one more instance of transforming a liability into an asset, and of con-

tinuing the long list of benefits derived from applied science.

We wish to discuss the method and the product in order to bring out a few points which we believe should be clarified. Every new method must be exposed to a searching inquiry and stand on its merits. Our remarks and objections are, therefore, to be viewed in the nature of constructive criticism, since every steel man sincerely hopes that the Ferron process is the final answer to the pickle liquor disposal problem.

Since the growth of stainless steel production has introduced considerable use of hydrofluoric and hydrochloric acid as noted—what will be the effect on the Ferron of varying percentages of calcium fluoride and also of calcium chloride? Or will it be necessary to handle stainless pickle liquor apart from sulphuric acid?

As mentioned in the report, there is undoubtedly a large demand for insulating material, building block and so forth. Competition with long established firms handling these products means that steel companies will have to develop trained sales organizations to market the Ferron products, or to handle such sales through a central co-operative sales agency.

While the development of insulating and building material from Ferron would be highly desirable from the standpoint of meeting costs of neutralizing pickle liquor, it can readily be appreciated that here there are many angles to be considered and not the least of these is the production angle. Since production of Ferron depends on volume of pickle liquor produced, which in turn depends on business conditions (which no man can foretell) it would be extremely difficult to build up a trade under these conditions.

In connection with neutralizing strong pickle liquor with lime, a major part of the calcium sulphate produced would be precipitated with the ferrous hydroxide, and if the dilutions were as noted (Fe SO_4 5 per cent and 2 per cent acid) the resulting precipitate would be fairly uniform.

A study of the relative volumes of strong pickle liquor and weak acid wash-water shows that the concentrated liquor is from 1 per cent to 5 per cent of the volume of wash-water. Therefore, if the wash-water and strong liquor were thrown together and precipitated as a unit, a product of very different analysis would result, since about 60 per cent of the Ca SO_4 produced by neutralization would be soluble in the filtrate. Would this material of very much higher iron content possess the same properties as Ferron from concentrated liquor?

While the total effluent from neutralized concentrated liquor alone would not amount to much, the total volume of concentrated liquor plus wash-water (in a plant using 400 tons 60 degrees Baume acid per month) would be over one million gallons per 24 hours. This water, since it would be saturated with Ca SO_4 plus varying proportions of lime would be unfit for plant use of any kind. This volume of hard water, discharged into a stream of reasonable flow would have very little effect on total hardness of stream water. However, if several steel companies using Ferron process were located on the same stream, total hardness would probably be increased several grains per gallon.

Finally the efficiency of the Ferron process has been previously stated as depending on precipitation at 150 degrees-160 degrees F. After hot pickle liquor was diluted to required concentration, some steam would be required to heat to 150 degrees-160 degrees F. If collecting tanks were used, liquor would be cold and more steam would be required to bring to required temperature. If wash-waters were included, (even for small plant cited 400 tons 60 degrees Baume acid per month), steam required to heat 1,000,000 plus gallons to 150 degrees F. would be quite an item in total cost of producing Ferron.

With the converting cost per ton of Ferron as given, what would be cost per net ton of steel pickled?

Installation of continuous automatic equipment probably will lower above figures but charging of overhead, depreciation, etc., to operating expense, the net figures above undoubtedly will double.

While there are many problems to be solved in connection with large scale installation and operation of the Ferron process, and also in connection with marketing the product, we believe Dr. Rentschler is to be congratulated for providing, "in the hour of need", a practical solution of a disposal problem as old as the steel industry.

W. W. HODGE: The American Iron and Steel Institute in establishing its research fellowship at Mellon Institute of Industrial Research had in mind focusing additional efforts of all the iron and steel manufacturers on this common problem of the proper disposal of the industries' waste products. Judging from the cordial receptions I have received and the information freely given to me in conferences and on plant inspection trips with officials of iron and steel companies, the executive and technical men in the steel industries are all in favor of this united effort to discover technically and economically satisfactory processes for the treatment of spent pickle liquors and other trade wastes, and to reduce objectionable stream pollution.

The proper disposal of waste pickle liquor has been a very difficult problem for many, many years. When I talked with Mr. Warren, Sharon Steel Corporation's Works, he told me he had at times been working on this problem for the past twenty-five years. Toward the end of a conference with a very prominent sanitary engineer in Chicago, who had been interested in the pickle liquor problem for thirty years, he said to me, "Just as a little souvenir of what you are up against, I will give you an article on 'Stream Pollution by Acid-Iron Wastes' ". It was a copy of the report on investigations of stream pollution by steel mill pickle liquor at an Ohio City, and the date of its publication was 1906. That was thirty-two years ago and the problem is still with us.

Shortly after they put me to work on this problem at Mellon Institute last July, I began to scout around for and investigate the different methods and processes proposed and available for the disposal and treatment of spent pickle liquors. I was of course interested to learn of the work that was being done to the development of this Ferron process. It appeared to me that Dr. Rentschler and his associates were making a serious attempt to obtain a commercial by-product

from this waste material. For many years with a number of steel companies, after the pickle liquor had been neutralized with lime, the question had been—where to put the resulting slurry or sludge. Some companies have tried putting the slurry into abandoned mines, some into caves, some into lagoons, and some hauled or pumped it onto low lying fields. There was not only the cost for the lime, but also the added expense of disposing of the resulting slurry or sludge. Now in the Ferron process there is a way proposed for obtaining a utilizable by-product from that waste sludge.

In our work on the American Iron and Steel Institute's industrial fellowship at Mellon Institute we have to date studies some twenty-five different processes which have been proposed, and many of them tried out, for the disposal and treatment of waste pickle liquors. Some British patents on processes for the treatment of spent pickle liquors date back to 1888, and articles were written on the subject in England and Germany some years earlier. From this large number of processes there are five or six which we are investigating more thoroughly. The work of this fellowship is under the general guidance of the Committee on Stream Pollution of the American Iron and Steel Institute. The Committee is composed of one president and six vice-presidents of different iron and steel companies. Their general instructions were not to overlook any process which offered possibilities for recovery of useful by-products from the waste pickle liquors, nor any potential markets for useful materials which can be made from pickle liquors. That is the plan on which we are proceeding with the work on this problem. We intend to keep posted about Ferron and trust we may be able to assist in finding more uses for this new material than those described in this paper.

W. E. STEINER: Dr. Rentschler's able paper was of particular interest to us because of the effluents which will be discharged into streams. We in Johnstown are not in as bad position as some of the concerns in this territory. We are actually improving the river water by discharging treated, alkaline waste into the stream. The river water is appreciably acid from mine wastage, which condition we are improving by treating the water with lime and discharging alkaline water from the manufacturing plants into the stream. It, of course, has an economic value. There are some by-products that we could secure by treatment of waste pickle liquor and removing the constituents in the water. I have in mind the recovery of sulphuric acid that could be used somewhere in our plant to good advantage. I can see where there are all kinds of possibilities for the treatment and recovery of the waste products.

GENE LA SCHOBER, JR.: What concerns me particularly is this: You mentioned briefly that you could also utilize this process with very dilute liquor. I would like you to go into that more thoroughly. If you had waste pickle liquors that would average 1½ per cent H_2SO_4 in quantities of one to two million gallons a month with iron sulphate contents of 10 to 25 per cent, how economical do you think the process would be? Do you think this $4.20 per ton of Ferron would be a fair figure for handling such diluents in arge quantities?

M. J. RENTSCHLER: I think that same question has been asked by a number of the preceding speakers. I am not sure that I can give you a satisfactory answer. Our experience has been limited to ten or twenty different kinds, but I can at least give you the groundwork that has to be considered so far as dilution is concerned. From a commercial standpoint we feel we want to manufacture a valuable product which we call "Ferron". It is, of course, necessary that you precipitate all the iron and calcium together. If you have a wash-water which contains nothing but sulphuric acid, it would certainly be foolish to try to produce Ferron. How then does ferrous sulphate help in producing a product which has strength? It is in our minds something like this—and our opinion is only an opinion, gentlemen, but we feel confident of our ground, at least in this connection. While this product is being formed and dried, there is undoubtedly produced a combination of ferrous hydroxide and calcium sulphate. This combination we call theoretically, ferroxy-calcium sulphate. The calcium sulphate or ferrous hydroxide of themselves possess no such properties as the Ferron I have described in this paper; but, when we precipitate the two jointly, we evidently get a combining action and a resulting product which has the properties of neither of the two most important ingredients. In other words if you take Ferron and try to dehydrate it you do not get the same result as when you dehydrate gypsum. If in the course of your precipitation you do not have some ferrous sulphate, obviously you get a product which has very little value. What are the limits? How far can we go as to dilution? It is possible to pump a large amount of your wash-water through the presses so long as you have enough iron to combine. Frankly, we have not determined the limits; but we do know as long as the ratio of iron hydroxide and calcium sulphate in the finished precipitate bears a relationship of 10 per cent ferrous hydroxide and the rest calcium sulphate, we get a satisfactory Ferron product. It may be possible to get a good product of much lower iron content than this. If you want to dilute your pickle liquor with wash-water, you can do so to an almost unlimited extent and still secure a good product. Of course, you have to pump your solution and it costs money to pump solutions; but you can work up a tremendous amount of wash-water in pickle liquor and get a good result. The reason for giving certain figures in my paper was because those figures seemed to apply best at Sharon. Every plant is a law unto itself. You cannot use the same rule in one plant that you use in another. It is a good plan to look at every plant as an individual problem just as we look at a steel plant. Steel plants as a rule are different because of the differences that you want to produce in your finished product. I feel confident you will be surprised at the wide dilution at which you can produce a satisfactory Ferron. If you have any problems of that kind, I am sure we shall be glad to do all we can to help you.

I believe the question of hardness of water has been mentioned. The solubility of calcium sulphate, as

you gentlemen know, is such that a saturated solution in water at ordinary temperature has a hardness of approximately 140 grains per gallon, the effluent discharged from the plant would have, at the most, a hardness of 140 grains per gallon, and if the wastewater is discharged as such, it might increase the hardness of the water into which it is discharged somewhat. However, you must remember that Ferron contains 50 per cent of water when it goes to the dryer, hence never reaches the stream. Consequently, the volume of your effluent is by no means as much as you might figure in your mind. Some basic work should be done also not only on the solubility of calcium hydroxide in calcium sulphate solution, but also on the solubility of calcium sulphate in calcium hydroxide solution. I have been unable to find any figures on this subject. If any of you know any figures on this problem, we would like to have them.

If it is true that your plant is so limited that you do not have the heat available for precipitation of Ferron, you can produce a satisfactory Ferron without the use of any heat. We find the precipitation is a little more complete at a temperature of about 70 degrees C., but you do not have to have that temperature. You can produce a satisfactory product by treating material at ordinary temperature.

T. G. TIMBY: In the finished product such as you have from this process, how much material is water soluble?

M. J. RENTSCHLER: Our observations indicate that Ferron is relatively insoluble in distilled water. Repeated washings do not dissolve even one percent of Ferron.

M. HARTENHEIM: Dr. Rentschler gave some figures for the heat-insulating property; has the new material also any electrical insulating property, and what is its density?

The calculation of cost was not quite as clear to me as I had wished. Would Dr. Rentschler be prepared to answer the question which is of most interest to the steel men wanting to utilize this process; namely, "What is the approximate cost for the installation of a plant converting about 10,000 gallons of pickle liquor daily into useful material?"

M. J. RENTSCHLER: As regards the first question on electrical insulation. The electrical insulation property varies fundamentally with the kind of Ferron that you make. There have been, I think, only two determinations made, and I am not sufficiently familiar with dielectric determinations so that I can give you exact figures. However, one of the companies interested in this material have made switch boxes from Ferron, and I understand the dielectric strength is plenty good enough for such work. We know, of course, that dielectric strength of all materials varies to a large extent, and any constant given should be applied to Ferron of a specific composition.

With regards to density, that also is determined by the filler that you use. If you use only a combination of ferric hydroxide and calcium sulphate, the density of your material is the density of those two products in similar proportion. It also must be borne in mind when discussing density that the ordinary mind has two units of density: How much does a cubic foot weigh? That in my opinion is relative density. The other fellow says: "What effect does it have as a filler in rubber?" When you use a filler in rubber it is the absolute density that applies; whereas when you weigh a cubic foot of material you have in mind only its relative density. Its absolute density is about 1.85; its relative from 40 to 120 pounds per cubic foot.

As to plant cost, I do not know that I am at liberty to give you any figures on that point. Perhaps Mr. Warren will be good enough to give you something on that.

G. S. WARREN: Our plant at Sharon, including all extra equipment, would run from $90,000 to $100,000, which is about $\frac{1}{4}$ or $\frac{1}{5}$ of the cost of some other plants of the same capacity.

H. K. IHRIG: Dr. Rentschler in his paper mentioned the volume of pickle liquor that is made every day; I think he mentioned one million gallons in the Youngstown territory. It seems that if the steel industry should go to the Ferron process to a large extent, that large volume of pickle liquor would mean a considerable amount of lime used every day. I wonder if any study has been made as to what amount of lime would be used, and how it might affect the cost of lime by increasing the demand?

M. J. RENTSCHLER: We have scrapped about that a good deal. Before I attempt to answer that question I want to say to you that some very interesting problems come up. If the steel companies want to get rid of their pickle liquor now, there are some of you would give it away if somebody would take it; but when they begin to make Ferron and dispose of it on the basis of $10.00 per 1,000 board feet, which is perfectly possible figuring a cost compared with lumber, I wonder what the steel companies will want for their pickle liquor? The rule works both ways. If, let us say, the lime people are selling their lime for $8.00 a ton today, as soon as they find you are making a product like Ferron from which you derive a profit, they are liable to raise the price. As far as the available supply is concerned, America has plenty of limestone. My professor used to say if the State of Pennsylvania would use lime only for agriculture, we would have enough for a million years. But they are not likely to sell it at the same price as now if they find you are making money out of it.

R. J. WEAN: The subject of Ferron is one that I will not touch, because I know nothing about chemistry, but many of you will no doubt say, "Why haven't we heard more about the plant for disposing of this pickle liquor and also for the manufacture of Ferron." Since it is our job to engineer and develop the equipment and the size of plants that are to be installed in steel mills, I would like to tell you how we are approaching that problem.

There probably are not two plants that have exactly the same requirements. We are quite aware of that. We are making a survey of the industry, and possibly a man has already visited some of your plants. Our

idea is to adopt standard size plants, so that there won't be "57 varieties" of sizes. We are also endeavoring to pass judgment on the equipment that goes into the plants; first, from the standpoint of whether it is good enough; second, equipment that will require a minimum amount of labor to operate, and low maintenance. We are not intending to take clay machinery and apply it to steel mills.

But first taking the acid problem, we are trying to find what is the range of acid content. We still have to deal with that; how many gallons of waste liquor per day, per month, and per year; so that we can decide whether we want to store some of it, or whether we want to have a plant that can use it as fast as you make it.

Filter presses have been so-and-so. We have been trying to find some fast, automatic way of doing it and keep the amount of power to a minimum. We won't recommend anything until we know it is right.

If we succeed in doing what we are trying to do, we will have a medium size, economical plant, and from there on up to 50,000 gallons a day, a plant which we have already estimated and laid out. We do not know whether we will have it in sizes of 5,000 gallons or 10,000 gallons; or working in 10,000 gallons with one filter press or with two filter presses; but when we get a complete cross section of your industrial problem, we hope to give you a fair idea of what is reasonably necessary from an equipment standpoint for a complete plant, so that when you get ready we will be able to tell what it will cost you, how much per day in labor and material, and what the price will be for the Ferron, for which a market is being developed, before we press you to install plants to produce Ferron.

It is about the only one of the items with which we have been associated where somebody was not in too big a hurry. Some of you fellows have had this problem for 35 or 40 years, so that another month or three or four months won't make any difference, as long as the final answer will be both economical and satisfactory.

M. J. RENTSCHLER: Answering Mr. Edwards' question on stainless steel strip, in view of the fact that you are using hydrofluoric, hydrochloric and nitric acids for pickling certain types of stainless steel, what is the effect on the effluent of the corresponding salts of lime produced from these acids in the Ferron process.

First let us consider hydrofluoric acid. Calcium fluoride is extremely insoluble, only one part dissolving in 27,000 parts of water. Therefore, hydrofluoric acid will work equally as well as sulphuric acid and no trouble whatever will be experienced here.

In regard to hydrochloric or muriatic acid as you may know it, calcium chloride resulting from the neutralization of this acid with lime is relatively soluble and a certain amount will undoubtedly find its way into the effluent. Mixed with a larger amount of other pickling liquor, however, the calcium chloride content will not be high and it is not nearly as objectionable a salt as magnesium chloride which might be encountered where other forms of neutralization are used.

Now as for nitric acid, this is not used in large percentages and the calcium nitrate resulting from it may be considered more as a friendly salt than otherwise. Nitrates are found in nearly all running waters and are actually beneficial, as you know, to plant growth. The small amount of soluble nitrates will certainly be of no harm to any water supply.

W. M. EDWARDS: What effect would calcium chloride or calcium fluoride have on your Ferron product? Would these compounds weaken the finished material?

M. J. RENTSCHLER: We have precipitated Ferron with calcium chloride and fluoride present to the extent of 10 per cent and the finished product has not shown any difference in structure or properties.

That brings up the question of the adsorption properties of Ferron. Some of these mineral salts are bound to be adsorbed by a product of this nature, and we have some very interesting results to report. If we take a block of Ferron and expose it to ammonia fumes, we find considerable ammonia is adsorbed by the product. It may be interesting as a comparison, if we take Texas bright stock oil which is usually clarified by Fuller's earth, the same result can be achieved with Ferron, but whereas Fuller's earth varies much in composition even from the same veins in the same locality, therefore, the oil companies have had difficulty to get uniform results. This does not apply to Ferron, because we have applied different grades of Ferron and they have all shown excellent clarifying results. The dry cleaners have had trouble in clarifying carbon chlorides. These solvents are used to take grease out of clothes and soon become saturated with fatty acids which are derived from perspiration of the body. We made a mixture of powdered Ferron with a light solvent containing fatty acids and other matter and noticed that filtration was enough to remove them completely so that the solvents could be used over again. This illustrates the adsorptive properties of the material. Some of the students at Case, in Cleveland, have taken the adsorptive properties of Ferron for graduating theses this year and we hope to have more information soon.

W. R. KERR: One question is of interest in connection with the permanent strength of Ferron when wet. Does it tend to slough down when wet as a building block or hollow tile might be in a very wet environment? What effect on strength does the wetting have?

M. J. RENTSCHLER: That brings up a very important matter regarding Ferron. Ferron, as we have said is approximately 50 percent pores. If you place water on Ferron, the water is instantly absorbed. As an illustration, one of our men uses a roll of Ferron as a blotter in his office, showing how absorbent the Ferron is. After drying if this material is immersed in water, it will not disintegrate. On subsequent drying you get exactly the same product as before subjecting it to moisture. But if not thoroughly dried you have not given it the set, consequently it does not have its normal strength. Ferron does not gain weight in moist atmosphere. Like a sponge, it does not take on moisture, but absorbs moisture when immersed

in water, drying out again on exposure to atmospheric currents. If you desire to use the material on the outside where it is exposed to water or rain, all you have to do is waterproof the surface. You can do this by half-a-dozen methods. For example, sodium silicate converts the surface of Ferron into insoluble calcium and iron silicates preventing further penetration by water, so that Ferron so treated can be exposed to rain for weeks without gaining weight. If you close all the pores of Ferron you have lost its insulating value so far as thermal conductivity is concerned. It is the air pores on which the insulating value of Ferron depends. However, a surface coating, enough to waterproof, has little effect on its insulation. It is true that the material can be compressed. The supposition is that ferric hydroxide does not lose its moisture below 1000 degrees F., so there is sufficient colloidal matter to give it combining power.

You can readily see that by manipulating the product in different ways you will get different properties in the finished product. Take two Ferron blocks, apply silicate of soda to the surfaces and press them together; in five minutes it is absolutely impossible to tear the two apart. It is a good way to bind the material together if that is what you want to do.

W. R. KERR: You mentioned a ratio of 10 per cent ferric hydroxide and the balance calcium sulphate. Is this to be interpreted as a figure for the optimum strength of the finished dried mass?

M. J. RENTSCHLER: A satisfactory material was produced if you had that ratio of ferric hydroxide and calcium sulphate in the finished product, however, we recommend a higher percentage of iron hydroxide. We believe the optimum proportions are equal molecular weights.

W. R. KERR: You have given some interesting figures for thermal conductivity. However, it was pointed out that the Ferron becomes dense at 900 degrees. This means that the voids close to an extent, and we should like to know what effect this closing of pores has on the slope of the thermal conductivity curve?

M. J. RENTSCHLER: The insulating value of Ferron, as I have explained, is due to the multitudinous microscopic air spaces contained throughout its structure. As these air spaces or voids are closed by either pressure or changing the manufacturing operations the insulating value will correspondingly decrease and the thermal-conductivity will, of course, increase.

We have closed the air spaces with a number of different materials. For example, the clay people are anxious to produce a roofing tile and other similar products of lighter weight by mixing say 50 per cent of Ferron with 50 per cent of clay. Such a mixture produces a much lighter weight material than if made from clay alone. We have also produced a number of kinds of crucibles in our laboratories. You might wish to try this in yours, and I suggest that you take some plastic Ferron and line the inside of an iron crucible with a quarter of an inch and let it dry for a few minutes in an oven or over a flame when the body of Ferron usually shrinks away from the wall of the crucible. It can be now turned out of the mold, and when dry enough to hold its shape can be put directly in the flame of a blow torch or Bunsen burner and you can melt lead and similar metals directly without fear of the crucible breaking.

Association Activities

CHICAGO DISTRICT SECTION

Tuesday, January 10

"SPEED CONTROL BY VOLTAGE CONTROL" by R. A. Geuder, Steel Mill Section, Reliance Electric & Engineering Company, Cleveland, Ohio.

CLEVELAND DISTRICT SECTION

Monday, January 16

"NEW PROCESS OF ELECTRIC DIRECT RESISTANCE PATENTING AND TEMPERING OF WIRE" by J. W. Morrison, Metallurgical Engineer, Cleveland Wire Spring Company, Cleveland, Ohio.

DETROIT DISTRICT SECTION

Tuesday, January 10

"PRACTICAL ASPECTS OF STEEL MAKING" by C. L. Altenburger, Research Engineer, Great Lakes Steel Corporation, Ecorse, Michigan.

PHILADELPHIA DISTRICT SECTION

Saturday, January 4

"ENGINEERING DESIGN OF MOTOR ROOMS AND CONTROL HOUSES" by C. P. Sullivan, Construction Engineering Department, General Electric Company, Schenectady, New York.

PITTSBURGH DISTRICT SECTION

Thursday, January 26

"PROTECTION OF BRANCH CIRCUITS FOR AUXILIARY MOTORS AND OTHER AUXILIARY SERVICE" by William Deans, Chief Engineer, I-T-E Circuit Breaker Company, Philadelphia, Pennsylvania.

February 28, 1939

"INSTALLING AND OPERATING GREASE LUBRICATING SYSTEMS" by L. W. Deutsch, Trabon Engineering Corporation, Cleveland, Ohio.

New Furnace FOLLOWS Modern DESIGN TRENDS

By J. H. SLATER, Supt.
Blast Furnace and Coke Ovens
REPUBLIC STEEL CORPORATION
CLEVELAND, OHIO

▲ THE No. 3 blast furnace recently erected at the Youngstown plant of the Republic Steel Corporation was blown in on October 5th, 1938, with a nominal capacity of 1000 tons of pig iron per day. This furnace was built on the site previously occupied by an old furnace built in 1905. The site was cleared of all steel work, foundation and cast house.

Due to the nature of the soil, which consists of layers of sand, gravel and clay to a depth of 70 to 75 feet, the use of piling is necessary in order to establish a solid

The layout of the new cast house is modern and convenient in every respect.

foundation. The old furnace had been built upon wooden piling, which it was found impossible to remove. It was then decided to attempt driving the new 16″ electric weld steel pipe piling down through the old wooden piles. This was successfully accomplished, using a 5000 lb. steam hammer with a drop of 3 feet. The first 20 to 30 feet of soil was soft and in many cases the 40 ft. length of pipe, after one blow of the hammer, would continue to penetrate 10–15 ft. without additional blows. A total of 180 piles were driven down to rock strata. The inside of the piles were then cleaned out with water and air at 140 lb. pressure, sealed at the bottom with two sacks of cement, and then filled with concrete. The 6 ft. thick concrete mat was then poured.

The new furnace, lines of which are shown in Figure 1, has a hearth diameter of 25 ft. 6 in., a bosh diameter of 28 ft. 3 in., and a stock line diameter of 19 ft. 6 in. The bosh angle is 83°–19′–32″, and the batter of the stack

View of the new furnace from the end of the cast house.

FIGURE 1—Sectional drawing of the new furnace, showing principal dimensions.

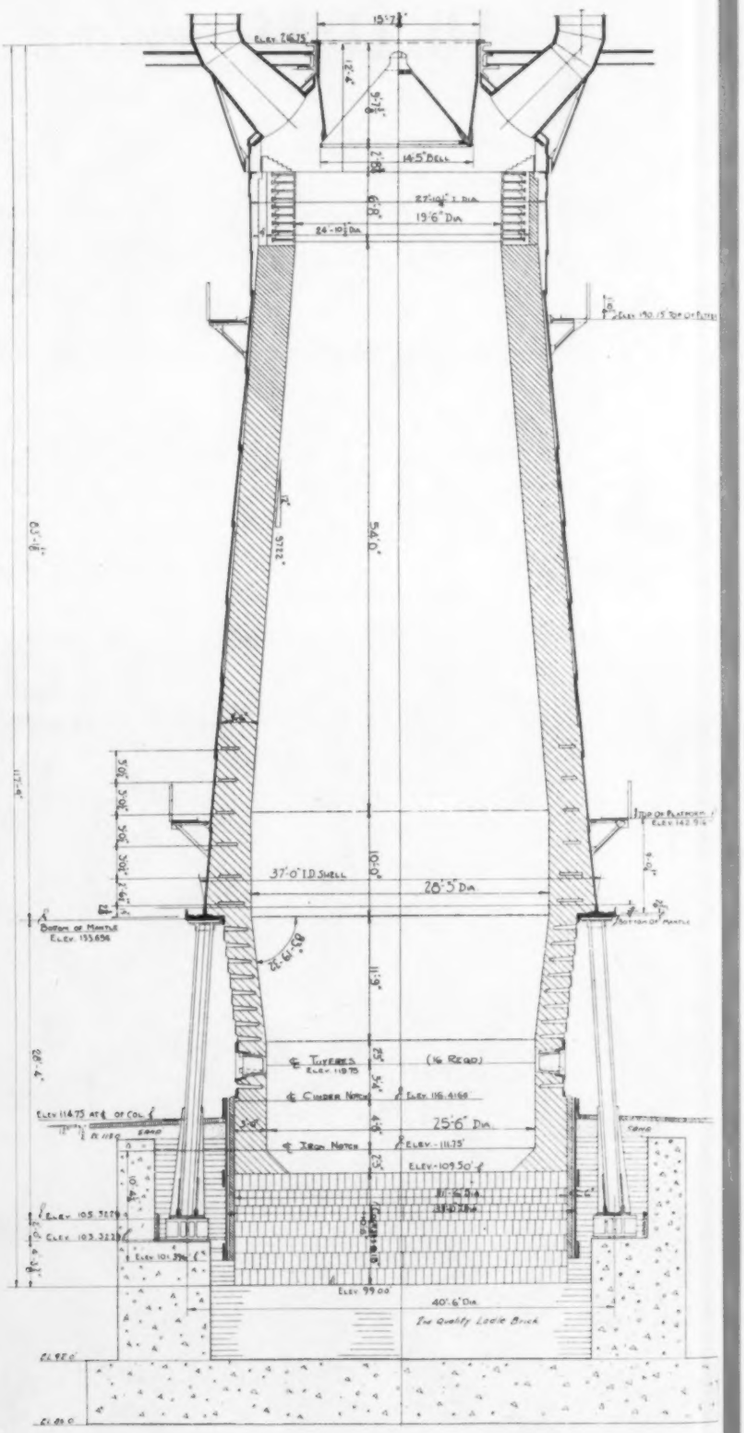


TABLE I. BLOW-IN RECORD

Series	No. Chgs.	Coke Chg.	Coke Series	Lbs. Stone		Diff.	Fce. Slag	Ore Burden			Total Ore	O.H. Slag	Slag Vol.	Ore / Coke	Tons Pig	Mn	Remarks
				Act.	Theo.			Cliff	McCook	Louise							
		30 Skips @ 5000	150000	67% Stone	33% Dolo.												10-2 Coke to coolers
1	3	20000	60000	2000	2700	—700	4000										10-3
2	3	20000	60000	2000	2700	—700	3800										
3	3	20000	60000	2000	2700	—700	3600										Total coke blank 390000 lbs.
4	3	20000	60000	2000	2700	—700	3600										After 4th series 4 ft. wood
5	5	20000	100000	4000	3657	+343	3400	4200	5300	500	10000		3330	.50	2.35	1.04	Filling-oos/cccc/ on top of
6	5	20000	100000	4200	3844	+356	3200	4600	5900	500	11000		3083	.55	2.59	1.00	coke
7	5	20000	100000	4300	4031	+269	3000	5000	6400	600	12000		2836	.60	2.83	1.00	
8	5	20000	100000	4500	4218	+282	2000	5400	7000	600	13000		2589	.65	3.07	.95	
9	5	20000	100000	4700	4405	+295	2000	5900	7400	700	14000		2342	.70	3.31	.95	
10	5	20000	100000	4900	4599	+301	2000	6400	7900	700	15000		2092	.75	3.55	.94	
11	5	20000	100000	5100	4852	+248	1000	6800	8400	800	16000		2002	.80	3.78	.98	
12	5	20000	100000	5400	5105	+295	1000	7300	8900	800	17000		1912	.85	4.01	.97	
13	10	20000	200000	5700	5358	+342	1000	7800	9400	800	18000		1822	.90	4.24	.97	10-5 Fce. 14′ below big bell
14	7	20000	140000	5900	5611	+289	1000	8300	9900	800	19000		1730	.95	4.47	.96	10-6 closed on 2nd chg. of
15	7	20000	140000	6100	5863	+237	1000	8700	10400	900	20000		1640	1.00	4.71	.99	series 12 blast on 2;15
16	5	20000	100000	6300	6005	+295	1000	9200	10900	900	21000		1596	1.05	4.95	.98	Oct. 5
17	5	20000	100000	6500	6157	+343	1000	9700	11400	900	22000		1552	1.10	5.19	.96	
18	5	20000	100000	6600	6304	+296	1000	10200	11900	900	23000		1508	1.15	5.43	.95	
19	10	20000	200000	6500	6456	+ 44	1000	10700	12300	1000	24000		1464	1.20	5.67	.93	
20	5	20000	100000	6600	6625	— 25	1000	11200	12800	1000	25000		1420	1.25	5.93	.92	10-7
21	5	20000	100000	6800	6819	— 19	1000	11700	13300	1000	26000		1395	1.30	6.17	.91	
22	5	20000	100000	6900	7013	—113	1000	12200	13800	1000	27000		1370	1.35	6.41	.90	
23	5	20000	100000	7100	7207	—107	1000	12100	14800	1100	28000		1345	1.40	6.65	.89	
24																	Skipped series 24
25	5	20000	100000	7400	7401	— 1	1000	13100	15800	1100	30000		1296	1.50	7.11	.88	
26																	Skipped series 26
27	5	20000	100000	7500	7685	—185	1000	12600	17850	1050	31500	1500	1372	1.57	7.52	1.06	Filling osccoosec/
28	3	20000	60000	7800	7971	—171	1000	14300	17600	1100	33000	1500	1321	1.65	7.85	1.05	
29	4	20000	80000	8400	8241	+159	1000	14820	18240	1140	34200	1500	1284	1.71	8.28	1.04	
30	4	20000	80000	8800	8479	+321	1000	15210	18720	1170	35100	1500	1252	1.76	8.52	1.03	
31	4	20000	80000	9000	8628	+372	1000	15600	19200	1200	36000	1500	1240	1.80	8.81	1.02	
32	4	20000	80000	9200	8777	+423	1000	15990	19680	1230	36900	1500	1227	1.85	9.10	1.00	
33	3	20000	60000	9400	8976	+424	1000	16510	20320	1270	38100	1500	1214	1.95	9.39	.99	
34	5	20000	100000	9800	9424	+376	1000	17680	21760	1360	40800	1500	1202	2.04	9.68	.98	
35	5	20000	100000	9900	9568	+332	1000	18070	22240	1390	41700	1500	1190	2.09	9.98	.97	
36	5	20000	100000	10100	9717	+383	1000	18460	22720	1420	42600	1500	1177	2.13	10.22	.96	
37	5	20000	100000	10200	9866	+334	1000	18850	23200	1480	43500	1500	1167	2.18	10.45	.96	
38	5	20000	100000	10000	9763	+237	1000	19240	23680	1480	44400	2500	1190	2.22	10.70	1.14	

is .9722″ in 12″. The working volume, from tuyeres to stock line, is 40,100 cu. ft.

The hearth is 12 ft. 6 in. high and the bosh 11 ft. 9 in. high. Above the mantle there is a straight section 10 ft. in height, followed by a 54 ft. high battered inwall and a stock line section of 6 ft. 8 in. height. Total brickwork height is about 95 ft., with a total furnace height of 107 ft. 3 in.

Hearth and bosh jackets are of heavy steel construction, the hearth being cooled by cast-iron water-cooled staves extending down 15 ft. from the cinder notch level. Bosh cooling consists of 316 standard bronze coolers arranged in eleven rows 18″ apart. Cooling is carried up about 15 ft. above the mantle, using 120 coolers arranged in six rows 3 ft. apart.

The lining required brick quantities as follows:—

	Actual Count	9″ Equivalents
Hearth and bosh.....	53035	114970
Inwall.....	83269	161343
Top.....	65548	123378
Total.....	201852	399691

The thickness of the bosh lining is 2 ft. 7½ in., while the shaft has a 3 ft. 6 in. lining. The stock line is protected for a depth of 6 ft. 8 in. by annealed cast steel abrasion plates bolted together in each plane and imbedded into the brickwork.

The mantle is built up of heavy steel plate and carries the weight of the furnace, and is in turn supported by eight heavy structural columns resting on a heavy cast-steel base ring.

The hearth of the furnace is built up of 10 ft. 6 in. of brickwork on top of 7 ft. of secondary brickwork, all resting on the 6 ft. concrete mat. The iron notch is placed 2 ft. 3 in. above the hearth level and at a slight angle to the center-line of the cast house. The cinder notch is placed 4 ft. 8 in. above the iron notch and at an angle of approximately 45 degrees from the iron notch, allowing over 250 tons of metal to be accumulated between casts. Sixteen tuyeres, 5″ x 15″ and 6″ x 15″, are used, on a plane 3 ft. 4 in. above the cinder notch.

Iron and slag runners are laid out to allow the use of eight 35 ton open top iron ladles on one side of the cast house and eight 320 cu. ft. slag ladles on the other side. Charging is accomplished by a newly installed double skip hoist using 200 cu. ft. skip buckets and operating at a speed of 600 ft. per min. The skip hoist operates under the usual automatic control system and is electrically interlocked with the scale car, the revolving distributor and the large and small bells to insure the proper cycle of operations, and is also equipped with over-speed, slack-cable and travel limit protection to provide safe operation at all times. The skip bridge is supported independently of the furnace top on an "A" frame.

In order to use the large charges so necessary to good operation of the modern large furnaces, space between the large and small bells is provided so that it is possible to accumulate an 85,000 lb. charging unit on the big bell before dumping. The big bell is 14 ft. 5 in. in diameter, allowing an annular clearance of 2 ft. 6½ in. around it. Bell gear is supported by the top framework of the furnace, and is operated by cylinders mounted in the cast house and powered by the cold blast.

Ore is handled by either of two existing bridges and is placed in new bins of heavy steel construction provided with hand-operated quadrant gates. Ore and stone are weighed in a new scale car. Coke is not weighed, due to its variable moisture content, but is measured by volume. Coke is passed over a ¾″ screen to remove the breeze.

There are four uptakes on the furnace, each 4 ft. 6 in. in diameter, converging into two down-comers, all unlined but provided with wearing plates at locations particularly subjected to abrasion. The gas cleaning system, which was not changed in the rebuild, consists of a dust catcher, a tower washer and an electrical precipitator. Dust content of the gas is reduced to .25–.30 grains per cu. ft. in the tower washer, while the precipitator reduces it further to a final figure of .01–.015 grains per cu. ft. A thermal expansion goggle valve is installed in the gas main after the dust catcher.

Blast is furnished by existing engines and is heated in the four two-pass center combustion 22′ x 97′ stoves used on the old furnace. New pressure burners, with individual built-in fans, were installed on the stoves.

TABLE II. ANALYSES OF BURDEN MATERIALS

Material	Fe	P	Mn	SiO_2	Al_2O_3	CaO+MgO	
McCook	53.90	.054	.21	9.32	.46	.43	
Cliff Group	52.26	.104	.26	6.71	2.23	1.75	
Louise	36.15	.142	9.16	8.90	3.24	.87	
Marble Head Stone		.009		1.26	.60	53.70	
Coke C No. 2		.030		5.11	2.22	.54	
O. H. Slag	15.00	1.050	6.00	15.00	3.60	37.82	

Two of the stoves have 3½″ square checker flues, totaling 42000 sq. ft. of heating surface, while the other two have oblong radial tile checkers, giving 90,000 sq. ft. of heating surface per stove. Automatic hot blast control is provided.

The furnace was dried out by circulating steam through the cooling water system and by blowing 12000 cu. ft. per min. of 500 degree air up through the furnace, gradually increasing this temperature to 800 degrees F.

Before starting to fill the furnace, eight wheelbarrow loads of coke breeze were packed around and in front of the iron notch. Then coke was charged up to the coolers, using 150,000 lb. Next, wood was placed to a depth of about 4 ft., after which filling proceeded according to the record given in Table I. The furnace was started with a blast volume of 20,000 cu. ft. per min., adding 1000 cu. ft. per min. each hour. Blast temperature was started at 1000 degrees F. The first cinder was flushed 18 hours after lighting the furnace and the first cast was made about 26 hours after lighting. Analyses of the early casts and slags are given in Table III.

The furnace has been operating under a blast volume of 56,000 cu. ft. per min., producing about 825 tons of iron per day with a coke rate of 1775 lb. per ton of iron. Blast pressures average about 18 lb. per sq. in., while the top temperature runs consistently under 350 degrees F. Top pressure runs about 20″ water column. Approximately 85 lb. of flue dust is produced per ton of iron. Gas analysis averages 13.8 per cent CO_2, 24.8 per cent CO, 2.2 per cent H_2, 59.2 per cent N_2. Slag volume is about 1200 lb. per ton on basic iron and about 1000 on bessemer iron.

TABLE III. ANALYSES OF IRON AND SLAG FROM BLOW-IN

Analyses of First Seventeen Casts

Cast No.	Time	Date	Sil.	Sul.	Phos.	Mn
1	4:30 P.M.	10–6	3.10	.039		
2	8:45 P.M.	10–6	2.60	.065		
3	1:50 A.M.	10–7	4.07	.029	.200	.63
4	6:25 A.M.	10–7	4.95	.026	.200	.68
5	10:50 A.M.	10–7	4.35	.019	.184	.66
6	7:15 P.M.	10–7	4.50	.014	.190	.80
7	12:45 P.M.	10–8	4.06	.017		1.03
8	6:00 A.M.	10–8	3.37	.021	.234	1.03
9	11:00 A.M.	10–8	3.38	.018		1.18
10	5:30 P.M.	10–8	2.93	.016	.250	1.24
11	10:30 P.M.	10–8	2.50	.016		1.14
12	3:45 A.M.	10–9	2.21	.018	.240	.94
13	9:30 A.M.	10–9	2.16	.020		1.38
14	3:00 P.M.	10–9	1.95	.025	.290	1.38
15	7:25 P.M.	10–9	1.75	.020		1.60
16	12:40 A.M.	10–10	2.20	.018	.278	1.78
17	5:20 A.M.	10–10	1.61	.017		1.52

Analyses of Slag from First Ten Flushes and First Five Casts

Flush	Time	Date	SiO_2	Al_2O_3	CaO	MgO	MnO	S	FeO
1st	8:15 A.M.	10–6	32.62	22.01	40.00	3.90	.37	1.50	.35
2nd	10:10 A.M.		32.46	20.24	40.90	4.71	.32	2.14	.30
3rd	11:30 A.M.		31.80	18.88	43.90	3.72	.32	2.26	.25
4th	12:45 P.M.		32.32	18.77	44.00	3.31	.21	2.28	.25
5th	3:00 P.M.		31.84	18.32	42.50	5.61	.23	2.30	.35
1st Cast	4:30 P.M.		31.84	19.42	43.60	2.96	.36	2.24	.70
6th	6:30 P.M.		33.54	15.84	44.00	3.35	.66	1.52	1.85
2nd Cast	8:45 P.M.								
7th	10:30 P.M.		32.32	16.76	46.00	3.25	.24	2.36	.25
8th	11:45 P.M.		28.46	20.22	46.30	3.40	.18	2.38	.25
3rd Cast	1:50 A.M.	10–7	29.48	19.99	46.10	2.64	.19	2.30	.45
4th Cast	6:15 A.M.		27.10	19.60	49.20	2.09	.13	2.76	.50
9th	9:00 A.M.		29.66	19.89	46.40	2.51	.22	2.04	.30
5th Cast	10:50 A.M.		28.30	20.66	46.80	2.48	.23	2.06	.50
10th	2:00 P.M.								

Developments in THE IRON and

By W. H. BURR
Chairman A. I. & S. E. Developments Committee and Electrical Superintendent
LUKENS STEEL CO., COATESVILLE, PA.

W. H. BURR

▲ THE real problems confronting the steel industry during the year 1938 were not those dealing with their products but were personnel problems and economic problems. Industry now realizes that the thing uppermost in the minds of their workers is steady employment and in some branches of industry real progress has actually been made toward that end during the past year.

The European situation is still uncertain and the attitude of our own government toward business is not yet definitely outlined. At present, however, indications are encouraging and, if reasonable assurance is given by the government to industry, the year 1939 should witness a general improvement in industrial conditions.

The progress made in the steel industry during the last 15 years has been linked very closely with the progress made in the electrical industry. Statistics show that the kilowatt hours generated yearly by the power and light companies have increased 100 per cent in the past 15 years and the total horsepower in motors installed on main roll drives has increased 200 per cent during the same period of time.

BLAST FURNACE

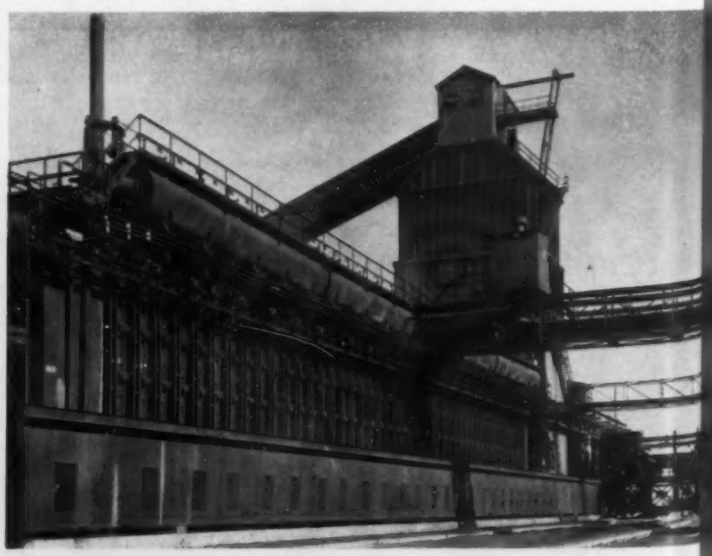
Both bells of a blast furnace can now be operated by a new single-unit double-drum bell hoist. Power is supplied by a single electric motor which assures positive operation with accurate control. The ropes for each bell are connected to a flat-type steel chain which wraps around an individual steel drum on the hoist machine. The turning of either drum winds or unwinds the chain, which raises or lowers the bell counterweight, opening or closing the bell.

Both drums float on the main gear shaft and receive their motion from lugs on the center of the large helical cut gear. Clockwise rotation of the driving gear from the neutral position, engages one of the drums without disturbing the other. Counter-clockwise rotation engages the opposite drum.

Both bells cannot open at the same time under normal operation, nor can one bell start to open before the other bell has closed. This assures a positive seal of the furnace during the regular charging sequence. When necessary both bells may be opened at the same time by opening one bell, anchoring it, then opening the other bell.

Each drum gives a crank-type pull on the bell chain during the first part of the bell opening and continues

During the year, coke producing facilities were expanded in a number of plants, either by installation of additional ovens or by construction of entire new batteries.



with a drum-type motion for the remainder of the operation. Ample slack rope assures a tight seal. The motion is the same for each operation and the very slow start, when opening, minimizes any tendency of the bells to swing.

In case of power failure during bell operation, either bell may be closed by releasing the machine brake and starting the machine manually.

STEEL INDUSTRY

During 1938

A precipitator has been designed for the efficient cleaning of coal gas, blast furnace gas, gas and air from processing in metallurgical, chemical and other industries, and for the removal of fly ash and other impurities from air or gas to be discharged to the atmosphere. Although new in this country, almost 150 units are in successful service abroad.

In this precipitator the electrodes are arranged in parallel planes, designed for utmost effectiveness. As the plate surfaces attract dust they are progressively shaken, loosening the particles and causing them to drop into a hopper underneath. The entire electrical field is always maintained at unimpaired intensity so that any dust eddies produced by the rapping are thereby reprecipitated immediately, preventing their escape from the precipitator. Depending upon the degree of air or gas cleaning necessary, it is said the precipitator can be built for any removal efficiency up to 99.9 per cent.

OPEN HEARTH

All the new open hearth furnaces built and put into operation during the year 1938, without a single exception, have been more fully equipped with measuring, recording, and controlling instruments than ever before. The temperature of the furnace roof, the temperature of the checker brick at the hot end of the checker chambers, and the temperatures of the waste gases before and after the waste heat boiler are being measured and recorded. The fuel, whether gaseous or liquid, is being metered and recorded, and in many cases controlled. The air for combustion is also being metered, recorded, and controlled. The furnace pressure is being measured, recorded, and controlled.

Another development which has made considerable progress during the past year is the measurement of the bath temperatures. One method which is being used in several shops is to have a radiation pyrometer installation which can be inserted through the wicket hole in the door and immersed into the bath from 12″ to 18″ to measure the molten metal temperature in around 6 to 8 seconds. This unit is developed so that one man can measure the temperature which is recorded on a large recording and indicating scale visible across the open hearth floor.

A new product has been produced which is a finely powdered insulating material used in the open hearth department in the treatment of fully killed steel. It is applied to the top of the ingot head in the hot top immediately after pouring and spreads over the exposed molten metal forming an insulating medium blanketing the molten metal a sufficient time for the gases to escape and the enclosures to rise to the top. It is said to reduce top discards and definitely reduce porosity and secondary pipes where such tendencies occur.

HEATING FURNACES

Early this year a new furnace for heating pipe skelp to be welded by the Fretz-Moon process was installed. This furnace was fashioned somewhat after furnaces that are now operating in England and in Germany. Maintenance costs of this furnace are said to be only a small percentage of what they are on other furnaces of this same type.

Coils of skelp are welded end to end and fed into the special heating furnace. The strip is dragged through this furnace by means of the welding mill at the discharge end.

Heat is applied to the strip as it passes through the furnace by means of a multiplicity of small burners firing through both side walls, in such a manner that the flame impinges on the edges of the skelp. As the strip travels through this sheet of flame the edges are heated to such a temperature that by blowing cold air on them just outside of the furnace at the welding mill the edges actually begin to melt. While in this plastic condition the edges are pressed together by means of the rolls on the mill and a perfect buttwelded pipe results.

After the newly formed pipe leaves the welding mill it is cut to lengths by a traveling hot saw. The lengths are then sized, straightened, descaled, and run out onto a cooling bed, after which they are removed by means of crane equipment.

Fuel for the furnace burners is natural gas and the combustion air is heated by means of metallic recuperators to approximately 900 degrees.

Automatic combustion control is provided on the furnace and the proper ratio of air to gas is maintained through all rates of firing. Temperature at the discharge end of the furnace runs to approximately 2850 degrees F. under steady production conditions.

Considerable scale is formed as the skelp is dragged through the hot furnace and as it leaves the discharge end of the furnace. Most of the scale deposited within the furnace is deposited near specially designed slag clean-outs, so that the slag may be removed easily. This flying scale which strikes the side walls of the

furnace necessitates the use of a special refractory lining that will withstand not only the high temperatures but the effect of the molten slag and flying scale also.

Another type of furnace which has been developed and installed for the steel industry is a gas fired, sloping hearth, pipe reheating furnace. This furnace heats pipe from below 2000 degrees F. to approximately 2400 degrees F., and has a capacity for heating better than 200 pounds per square foot per hour.

The pipe is pushed into the furnace by means of a chain type pusher, and the skids within the furnace are water-cooled pipes that have wearing strips welded along the top. The pipe then rolls down the special roll down piers and is pushed out of the furnace by means of a chain type pusher using a long water-cooled pusher head. The size of the pipe handled is as large as 9 inches in diameter by 22 feet long.

A quadruple fired slab or billet heating furnace with the proper application of fuel makes the maximum use of the entire furnace hearth from the heating standpoint and makes permissible the use of milder temperatures that are essential to quality heating.

The method of ingot heating has made decided progress in the development of dual temperature control in which the maximum and minimum furnace temperatures are automatically controlled in conjunction with combustion control and pressure control to produce a combined operation and record of a complete heat saturation of the ingot from surface to core and top to butt.

Also in this development is a new and practical method of arriving at predetermined ingot temperatures within practical limits over an adjustable range of rolling temperatures for various grades of steel.

This system has been in operation for over a year and during this time there has developed considerable information upon the relation of furnace atmosphere and the time and temperature factor with respect to the formation of primary and secondary scale.

During the year 1938 there has been developed a cylindrical bell type furnace fired with vertical radiant tubes, for use in wide or narrow strip coil annealing and in wire and rod coil annealing.

This furnace is designed to utilize the principle of gas fired radiant tubes to place the source of all heat input at the same distance from the charge and by the use of a re-circulating fan in the base of the furnace, to produce early uniformity of temperature distribution.

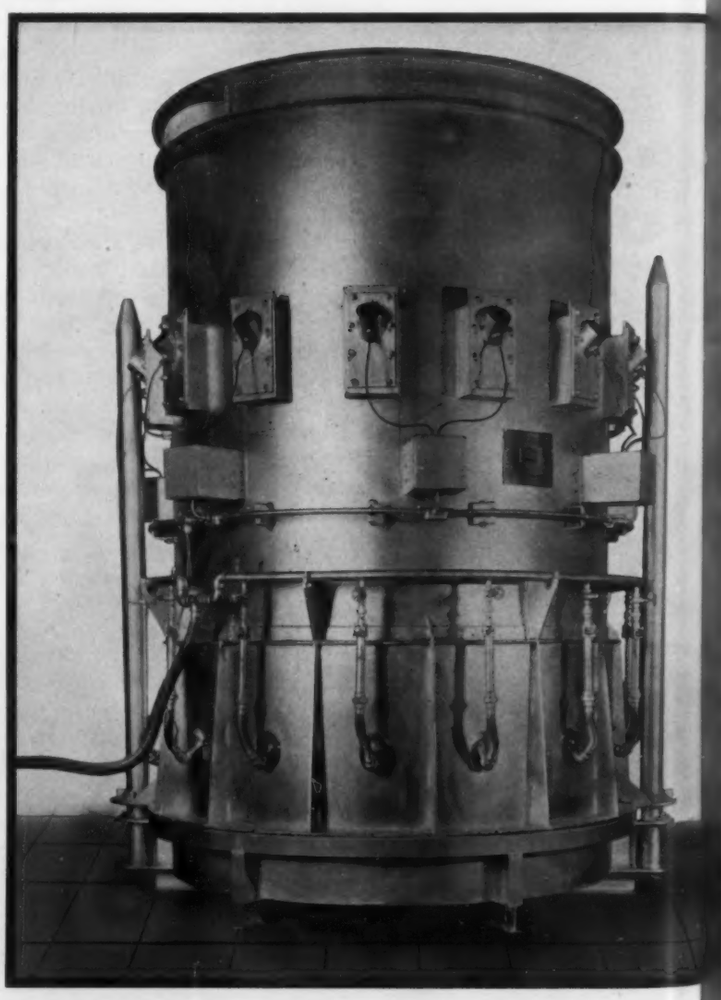
While the furnace was primarily designed for use on narrow strip coil for all ranges of carbon, it is especially useful for special charges in wide coils, also where short cycles and special quality are desired. This same furnace, with very little change in design, is entirely suitable for the needs of the wire industry in process annealing and bright annealing of all carbon ranges and in spheroidizing rod and wire coils.

For handling wire, the furnace has been designed and built to allow the placing of a number of stacks of wire on the same base plate with the especially desirable features of creating circulation up each stack of wire and also up the center of the charge without the necessity of having definite positions for each coil on the base. This eliminates the exact care in placing charges and speeds up the handling of the material in and out of the furnace.

Several electric strip annealing furnaces were built in 1938. Among these the continuous catenary furnace for strip steel deserves particular attention. As many as seven strips may be run through this furnace side by side. Temperatures as high as 2000 degrees F. may be maintained. A very complete electrical equipment is being supplied not only for the furnace itself, but for such auxiliaries as feed reels, pinch rolls, take-up reels, etc. Several interesting types of electric furnaces are being built at the present time for an aluminum sheet rolling plant to be located abroad. The furnaces themselves are designed and will be built in the U. S. A. Among these furnaces the following types are involved: soaking pit furnace for aluminum ingots, chain conveyor furnace for aluminum slabs, cylindrical pit furnaces for aluminum coil annealing, salt bath furnaces for heat treatment of aluminum sheets.

Modern high frequency induction heating furnaces are said to offer a new conception of time, quality and uniformity. Round stock 2⅜" in diameter can be heated for forging in 90 seconds. Zone hardening is now accomplished in from 3 to 7 seconds and the cost of electricity under these conditions is very nominal

This cylindrical bell-type furnace is heated by means of vertical radiant tubes, and is used in annealing strip, wire or rod coils.



when compared to the results obtained. These furnaces are now available in sizes ranging from 1 ounce to 8 tons.

For heating rounds for piercing in continuous seamless tube mills, the common practice in the past has been to employ a furnace with a sloping refractory hearth. The rounds were rolled down the hearth manually by operators working through doors along both sides of the furnace. This was a tedious, time-taking, fuel-wasting and expensive operation. During the past year, two furnaces were placed in operation, having a capacity of 50 tons per hour, in which the rounds are progressed through the furnace by a walking beam conveyor. This type of conveyor has been very successful in other types of furnaces such as normalizers operating at lower temperatures. However, this is believed to be the first application of a walking beam conveyor to a round heating furnace operating at 2250 degrees F.

REFRACTORIES AND FURNACE AUXILIARIES

Several steel companies recently have derived economies by using insulating firebrick in soaking pit covers. Because of their light weight such brick have lightened the cover structure materially, requiring less power and lighter motors. The relative ease of handling lighter covers has reduced damage to brickwork and lessened the extent and frequency of necessary repairs. The covers in use have given longer service life than those built of heavy firebrick. Because of their low heat storage and thermal conductivity, insulating firebrick have realized appreciable fuel savings in the pits in which they are used. Sprung arch construction has been employed in some installations; in others the flat suspended roof is preferred.

Covers designed for the use of such insulating firebrick can be built of lighter members and with less bracing than those designed for the use of heavy firebrick, thus affording a saving in construction costs. It is a safe practice to use a ring of heavy firebrick around the edges of a cover built of insulating firebrick, to resist the wear and abrasion to which these parts of covers are normally subjected.

Three materials for making light-weight concrete for refractory insulation purposes include light-weight aggregate, to which both cement and water must be added to form a concrete, and two premixed materials to which it is necessary to add only water to form concrete. The one is suitable for 2000 degrees F. service and the other for 2200 degrees F. Lightweight aggregate may be mixed with Portland cement or a high early-strength cement or a high alumina cement to obtain concretes of varying characteristics suitable for service at temperatures from 2000 to 2200 degrees F. These materials form extremely light and strong concretes with high insulating values, a density of about 50 pounds per cubic foot, and a cold crushing strength of 70 tons per square foot. They are used in forming foundation mats for all types of industrial and boiler furnaces, baffles, door linings, monolithic linings for small furnaces, combustion chambers for domestic oil burner installations, and backing-up insulating for pit annealers.

The idea of firing oil and tar in soaking pits and reheating furnaces, already designed and equipped for gas firing, has received the attention of engineers in the steel industry during the past year. Suitable equipment for fuel-air ratio control, on oil or tar as well as gas, however, has until recently been unavailable, making it necessary to install duplicate fuel-air ratio control for oil similar to that for gas firing.

To supply the need for such equipment without resorting to duplication of apparatus, there has been developed a combination tar and oil measuring and regulator loading system, whereby it is possible to accomplish fuel-air ratio control with either gas or liquid fuels, with the same regulating equipment. The standard type gas-air ratio regulator is now designed to permit mounting of the oil control apparatus, and in operation, the air flow regulator proportions air to whichever fuel is being used. The air control equipment is the same in either case, and the only operation required of the furnace operator is to admit the desired fuel to the furnace. The ratio equipment is designed in such a manner that the fuel not being used does not affect the regulator, and it is therefore unnecessary to make any adjustments on the regulating equipment in going from one fuel to the other. The same or different percentages of excess air for either fuel can be obtained with the same ratio setting if desired, and at the same time, the percentage of excess air is adjustable by operation of a convenient handwheel at the panel.

Where steam atomizing burners are used in connection with liquid fuel firing, steam pressure is also controlled automatically in accordance with the rate of oil flow to effect the most efficient atomization at both high and low ratings. The flexibility of the combination oil and gas-air ratio regulating equipment makes it adaptable to installations where it is desired to stabilize gas pressure by resorting to liquid fuel firing when the gas supply becomes dangerously low.

MILLS AND AUXILIARIES

One of the new slabbing mills will use a 10,000 hp. twin motor reversing drive for the main rolls and a 2000 hp. reversing motor for the edging rolls. This mill will be unusual in that the vertical edging rolls will be in a separate stand some 30 feet removed from the horizontal rolls. Edging passes will be made independently.

A reversing universal slabbing mill which has horizontal rolls and vertical rolls in the same housing was placed in operation in the Pittsburgh district. This mill has a 10,000 hp. twin-motor drive for the main rolls and a 3000 hp. for the edging rolls. Reductions are made in both sets of rolls simultaneously and in either direction.

A new 44-inch hot strip mill has four roughing stands, driven at a constant speed by separate motors. The passes are relatively long. Flywheels would be of little use. 2500 hp. synchronous motors were chosen for these drives. Here again the question of excitation and pull-out torque was given consideration. With its rated excitation the 2500 hp. motor is capable of developing up to 250 per cent torque, or 6250 hp. Ordinarily, this is ample. However, if the slab is too cold,

or if the supply voltage is abnormally low, the potential danger of pulling out of step is at hand. It was decided, therefore, to normally operate these motors underexcited, which will be for 80-90 per cent of total time. A limit switch is located a short distance ahead of each stand. When the slab hits the switch, full excitation, or over-excitation, is applied to the motor. After the slab passes over the limit switch, and a short time interval has elapsed, the over-excitation is removed.

Included in construction work this year was a project requiring new equipment for extensive changes to one of the early wide strip mills. A program of widening the mill and rearranging the stands to handle longer slabs involved one 5000 hp. and two 4000 hp. synchronous motors, a 2500 hp. induction motor and two 4000 hp., 175/350 rpm., 600 volt d-c. motors.

Several tandem and reversing cold strip mills were built and put in service during the last year. One 5-stand tandem mill for rolling tin plate has been equipped with electrical tensiometers to automatically control the tension between the stands. The same mill has been also provided with automatic finishing gauge control.

A four roll edger was designed to put round or square edges on cold rolled strip in the same operation and handling as when stock is being slit or rolled in a single band. The principal can be applied to one or multiples as they are split and wound. It works equally well on all gauges and is very useful in the production of multiples from a single band where very close tolerances and exactly formed edges are required.

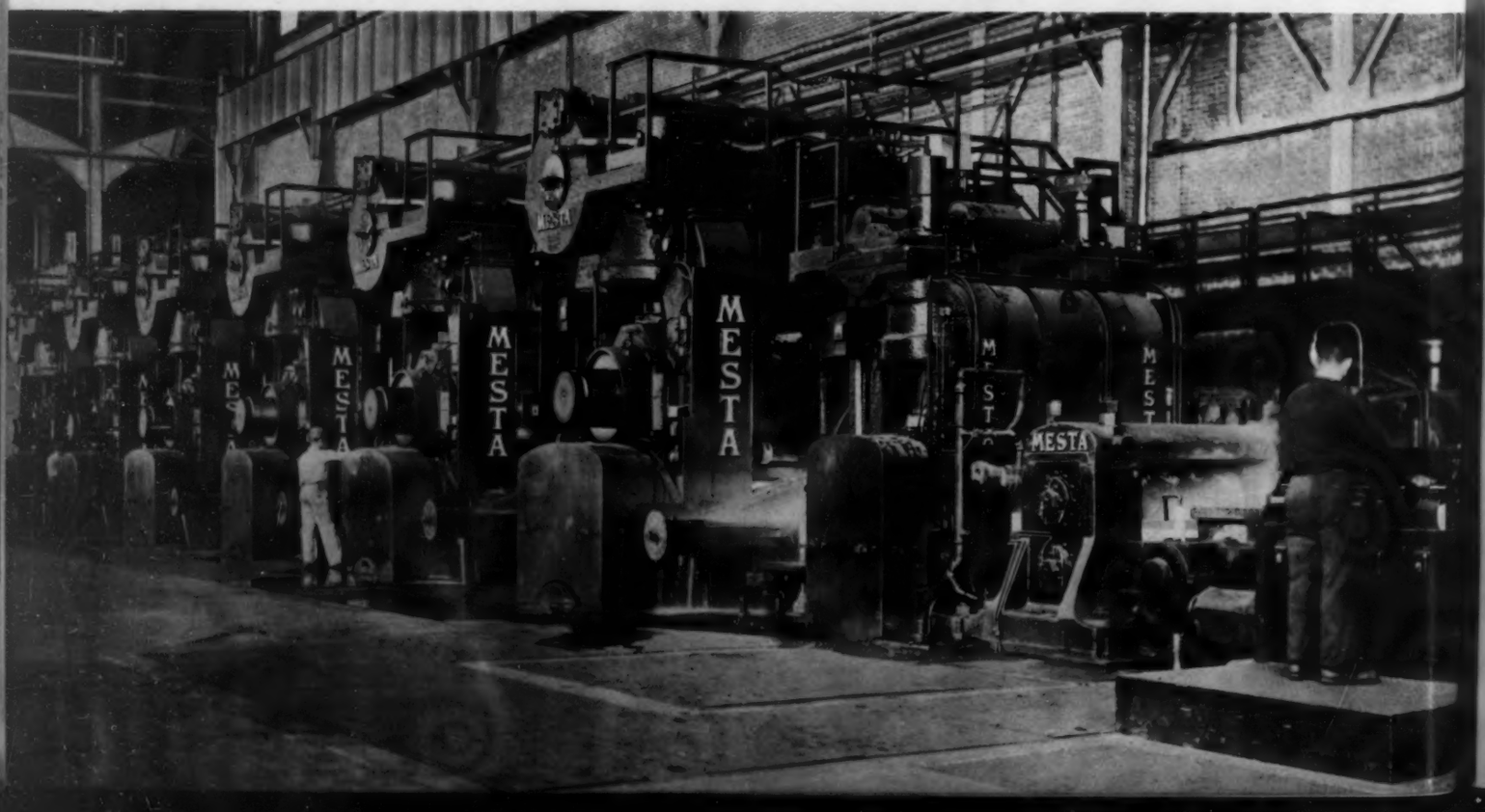
A new 54" skin pass mill of novel design will have a 500 hp. main motor, a tension device with each roll independently driven by a 150 hp. motor, a 300 hp. reel motor, two 25 kw. drag reel generators and a tensiometer. Unusual flexibility of tension control will be provided with this arrangement.

The drives for a two stand skin pass mill placed in operation during the year are illustrative of the refinements which are being incorporated in cold roll mills. In order to simplify the drives and to take advantage of the inherently lower flywheel effect of slow speed motors, this mill is direct driven throughout, thus eliminating all gearing. Two 25 kw. 90/360 rpm. generators are direct connected to the feed reels. The two main stands and the delivery tension device are each direct driven by 1—350 hp., 215/430 rpm. motor. A 150 hp., 95/380 rpm. motor is direct connected to the winding reel. The reduction in flywheel effect obtained by the use of slow speed motors is of material assistance in controlling the strip tension during acceleration and deceleration.

It is reported that a composite type of roll, for work rolls, for 4-high hot and cold strip mills, has at this stage of development, gone far towards being the ideal one for this application. As the name implies, the composite roll is one which is compounded with body shell of one material. and the body core, necks and wabblers of another. Both materials are integrally knitted together. There is a perfect bond between the two metals. They make a unit casting and one in which the two parts are non-separable by any mechanical means. The body face is of an alloy cast iron and forms a clear cut chill of a uniform homogeneous structure. They have better finishing qualities and at the same time are stronger to resist breakage and spalling. The composition of the body cores, necks and wabblers are so adjusted as to perfectly cushion the shell and provide more than sufficient strength to carry the torque and transverse stresses involved without failure.

A vertical edger for continuous and semi-continuous merchant and rod mills supplements the present finishing stand and gives greater accuracy for much longer periods of time than can be obtained from mills not so equipped. The entire mechanism is designed to work behind old or existing installations without removing or interfering with them and the mill can operate with or without when necessary without removal of equip-

Continuous strip mill construction proceeded gradually through the year, several new hot mills being installed.



ment from train line. This apparatus should particularly appeal to rollers of very close tolerance products, ferrous and non-ferrous.

Another development in connection with the tin plate line is a strip feeding device. This unit consists of a series of chains and is either hand cranked or motor driven. The chains operate between the grids. If at any time the strip should break, either before or in the electrolytic cleaning tank, the leading end of the trailing strip may then be clipped to this chain and by driving the chain it can be pulled between the grids through the electrolytic tank and out at the discharge end where it may be fed through the pinch rolls, tension rolls, and onto the reel in the usual manner. The development of the strip feeder makes it unnecessary for the operator to get into the electrolytic tank for feeding of the strip between the grids.

A new multi-speed screwdown development provides an ultra-rapid screw down of automatic or semi-automatic design and furnishes means for almost instantaneous return to starting position after a series of passes have been made. The design and principle can be applied equally as well to existing mills as to those of entirely new construction. The application is particularly effective on slabbing, universal and three-high mills where a very high efficiency and large number of pieces are required per turn.

Recently there has been patented a new type slab-turner which is relatively inexpensive, efficient and simple of operation and which may be installed in new or existing lines without the necessity of making radical changes in existing equipment or rolling methods. The new type slab-turner operates rapidly, is fully automatic, relatively inexpensive and compact so that very little space is required for its installation. Thus, the engaging members may be positioned as close to the delivery side of the mill as the length of slab permits for as soon as the trailing end leaves the mill, the slab-turner may engage the leading edge and cause the slab to turn.

Fluid operated pistons are positioned one above and one below the table, being clear to operate between the rollers. A trip mechanism which is engaged by the slab as it passes along the table to the turning device actuates a valve which admits fluid under pressure to the cylinders, thus causing the pistons to engage the slab on the top and bottom sides to restrain its further direct forward movement. The table rollers then cause the slab to rotate about the center line of the pistons which act as the pivot point, the slab engaging piston ends being machined to make point contact with the slab or having anti-friction bearings mounted therein to permit the slab to turn easily.

The heaviest tandem wire drawing machine built to date was placed in operation during the year. This machine has seven capstans, each driven by a 60/75 hp., d-c. adjustable speed motor.

FINISHING EQUIPMENT

Another development along the lines of scale removal from hot rolled strip has been the dry process or the abrader. There is a definite field for such a process where cold reduction mills are located within the city limits and the acid fumes and acid disposal becomes a real problem. One unit now under development can also be used for resurfacing steel strip and sheets, and to take scale off non-ferrous plates and bars. Further development along this line is now in progress and it is to be expected that this development will be looked upon with favor in the very near future.

There has also been developed a powered cleaner used in hot solution in the mechanical and electrolytic cleaning of strip steel prior to plating. It is said to be a balanced cleaner permitting absolute uniformity in the cleaning operation. Tin house rejects due to lack

The year was also marked by considerable activity in the modernization and widening of existing strip mills.

of uniformity have been reduced to a minimum by its use.

Mill operators must carefully inspect tinplate for pinholes which are apt to develop during the rolling process. An electrical equipment has been developed to facilitate this task and to make this inspection not only easier but surer. The equipment is ordinarily installed in conjunction with a shearing and classifying line and consists of a "scanning head" which includes a number of phototubes located beneath the strip. In this manner minute pinholes as small as $\frac{1}{64}$ in. can be detected in a moving strip at speeds up to 900 feet per minute. The defective sheets are diverted automatically into a pile of "rejects".

It appears necessary to take into consideration the possible effect on finishing equipment of the definite trend in the direction of composite or clad metals. Distinct progress has been made in the last few years in electro-deposited metals and strip steel with copper, nickel and even brass surfaces. This material is now available and on the market. The material is cold finished to an excellent surface and meets with customer acceptance. Sales of such an attractive product in the field of composite metals will naturally lead to further exploration and development.

It is conceivable that material of tin plate thickness might be made with a surface of 18 per cent chrome and 8 per cent nickel and that 40 pounds of alloy per ton of steel would be sufficient to make the material usable for many purposes which tin plate and galvanized plate are now used.

The trend toward wider mills seems to have halted, the record width having been reached in 1937.

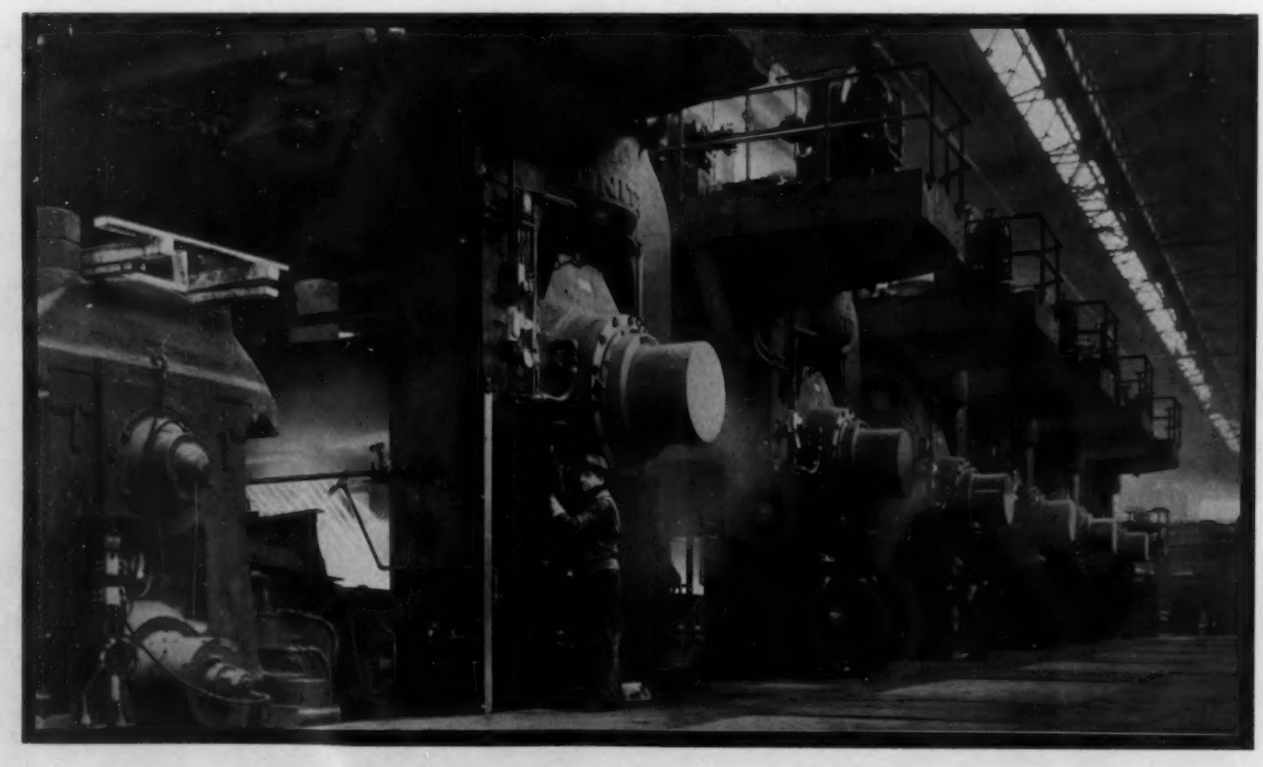
ELECTRICAL EQUIPMENT

This year again flat rolled products held the most prominent position in the steel industry. Motor drives for mills making this product used three fourths of the total number of new motors furnished during the year. The remaining 25 per cent were divided among 6 different type mills. This naturally raises the question —where is the saturation point in mills rolling flat rolled products?

It is interesting to note that the ratio of direct current drives and alternating current drives installed on main rolls during the year was 3 to 1. Synchronous motors are still finding new applications and each year larger motors of this type are being used on main roll drives.

The largest frequency changer set in the steel industry has been furnished for the Maryland Plant of the Bethlehem Steel Company. This set is equipped with a 28,150 kva., 60 cycle unit, and a 25,000 kva., 25 cycle unit. The 3500 kw., 600 volt d-c. generator is also mounted on this set and is used for supplying power to a 5-stand tandem cold strip mill. The same generator is used as a starting motor for bringing the frequency changer set to speed. Complete automatic synchronizing equipment is used in conjunction with this equipment.

The use of low voltage, high amperage generators for electro-chemical treatment of the surface of steel was until recently mainly confined to a separate small electro-plating department. Today such generators are used as part of the regular production processes. To meet this need a line of electro-deposition motor generator sets for electro-cleaning, electro-pickling and continuous strip plating has been developed. These machines are furnished for voltages which range from 6 to 45 volts and from 500 to 20,000 amperes output. In order to provide steady voltage at all degrees of regulation the generators are separately excited which



is essential in continuous processes. The substitution of welded construction for the usual castings permits a lighter and more compact machine.

A polyphase induction motor having characteristics similar to a direct-current shunt motor has been developed. The motor, which is known as the "polyspeed" motor, is capable of being operated at an infinite number of speeds between zero speed and 1720 rpm. At present the motors are available in sizes up to 7½ hp., for operation on 220, 440 or 550 volts, three phase, sixty cycle.

Features include fully continuous speed regulation without rheostat losses; speed practically independent of the load; constant torque through the entire speed range; high starting torque—up to 400 per cent; full-load starting torque with little more than full-load starting current; full-voltage starting; dynamic braking; and remote and automatic control of speed, if desired.

Regulation of speed is obtained by applying a bucking or an aiding voltage to the motor brushes. The stator core and winding of the motor is similar to that of an induction motor, while the rotor is similar to a direct-current motor armature. The adjustable voltage to apply to the motor brushes is obtained by means of the induction-type voltage regulator. By adjusting the bucking voltage, the motor can be made to run at any speed from stand-still to a speed slightly below the synchronous speed of 1200 rpm. By a further adjustment of the regulator an aiding voltage is applied to the brushes making it possible to run the motor through synchronous speed and on up to 1720 rpm. Operation at speeds below 600 rpm. is possible for short periods of time only without some external source of air for cooling.

For a number of years the conventional distribution transformer contained hundreds of hand assembled laminations but this year a new type transformer has been made which uses a continuous machine wound steel ribbon for the magnetic circuit. This is said to use this material more effectively, reducing the size, weight and total losses of the transformer.

A complete line of direct current automatic starters and machine tool controllers using a new principle for timing the acceleration has been developed. In these controllers the timing is obtained by using the time period necessary to discharge a condenser. When the starting button is pressed a 3-armature relay is energized and closes. One armature on this relay closes a contactor which in turn energizes the main line contactor. When the contactor closes, an interlock on that contactor breaks the circuit to the coil of the relay. A condenser is connected across the relay coil and for the period required to discharge the condenser the armatures of the relay are held closed. When the condenser discharge has died away, the armatures release and contacts on them energize accelerating contactors. The drop-out time of the armatures is independently adjustable by varying the magnetic gaps. In this way a very accurate timing is obtained without the use of any moving parts and a timing which is also independent of load or of temperature conditions. A second relay similar to the armature accelerating relay but having normally open contacts is used to insert resistance into the shunt field circuit in two steps for acceleration above base speed

In another new system of acceleration for motor starters the timing of the successive acceleration steps is obtained by a simple, condenser-charge neon-tube

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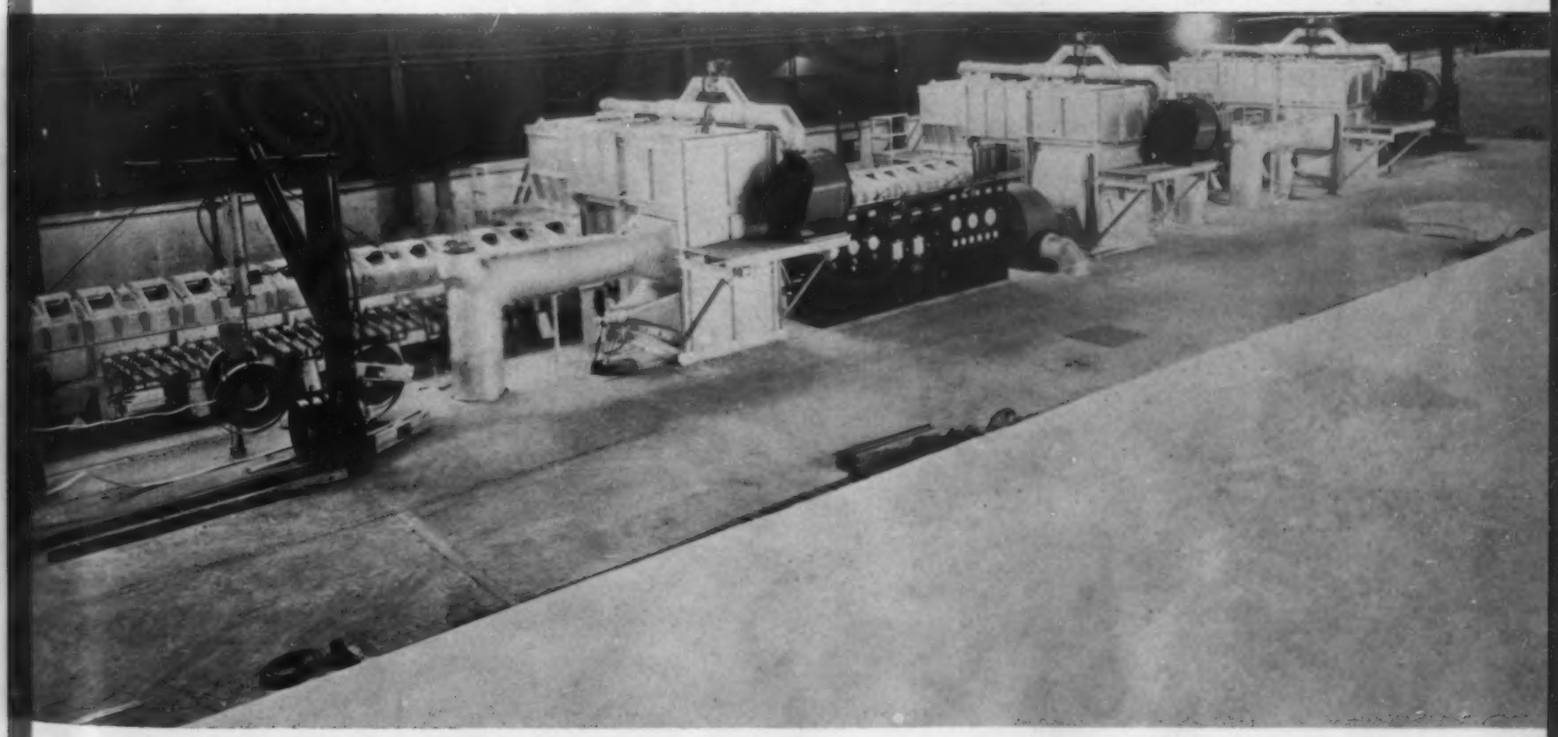
View of a modern furnace for heating skelp in the continuous process for the production of butt-welded pipe.



discharge circuit. It uses a new especially rugged neon type tube supported in fuse clips, and operates, in turn, control circuit relays for each acceleration step. This timing circuit has great accuracy combined with flexibility of adjustment and starters using this system are particularly well suited to applications in which fly-wheel effect of the load requires longer periods of acceleration than are available in conventional starters.

It is a well known fact that the torque of a wound rotor motor at any speed is determined by the value of the secondary resistance in the rotor circuit. With this in mind, it is clear that in order to follow a predetermined acceleration torque curve, it is necessary to cut out secondary resistance of known values at proper speeds. The new frequency relay allows this ideal condition. The relay operates on a resonant circuit and is responsive to the value of slip frequency of the rotor. The a-c. wound rotor motor is unlike the direct current motor in that forced acceleration of the direct current motor increases the motor torque until the motor starts or the overload relays trip, but any attempt to force acceleration of a wound rotor motor by cutting out resistance more rapidly than the motor is able to accelerate its load, results only in reducing rather than increasing motor torque.

The frequency relay is extremely accurate and finds a very important application on starters or controllers designed to provide a quick stop by plugging the motor. A frequency relay designed to operate exactly at the zero speed frequency is used to open the reverse torque contactors at the instant the motor comes to rest. This eliminates the use of so-called zero speed switches or other mechanical devices attached to the machine to interrupt the plugging contactor control circuit when the motor has been brought to standstill.

There is a new a-c. hoist controller of the magnetic type using the new frequency relay for control of the acceleration in the hoisting direction. Frequency relays are also used to control very important functions in the lowering direction. Due to the characteristics of this relay, functioning with extreme accuracy on slip frequency of the motor, it makes an accurate and dependable speed limiting device, and this permits incorporating features into the control that have not heretofore been obtainable.

The first four points in the lowering direction of the master controller are counter-torque points graduated from a weak counter-torque point on No. 4 to a strong counter-torque point on No. 1. An attempt to lower heavy loads on weak counter-torque point No. 4 might result in excessive speed. However this is prevented by a frequency relay which transfers the connection to a point of higher counter-torque value should speed exceed a predetermined value.

Point No. 5 applies power to the motor with all secondary resistance in circuit permitting short inching movements. Excessive speeds would be possible on this step with heavy overhauling loads but again the frequency relay prevents this by closing the resistance short circuiting contactor at a predetermined speed.

Hyper-synchronous speeds with overhauling loads in excess of the synchronous speed of the motor are obtained by operating on secondary resistance on point No. 6. Here, again, a frequency relay is used to prevent excessive speeds on this point. This development approaches the performance obtained with direct current cranes.

Another new development providing overload protection consists of a panel-mounted contactor with a special overload relay equipped with a ratchet lock-out device and a time-delay relay, enclosed in a drip-proof cabinet with indicating bull's eye in the front of the door.

On occasional overloads, the overload relay trips out the contactor and after a time delay the contactor automatically closes again. This operation is repeated for a predetermined number of open and close cycles, which may be selected from 1 to 6, after which the relay locks out and it is necessary to press the resetting but-

There was more activity in the blooming mill field than has been the case for some years, quite a number of new installations being made or in progress.

ton which resets the ratcheting device on the overload relay.

Among the outstanding developments of the year is the new line of fluorescent Mazda lamps which produce from 50 to 200 times as much colored light from the energy consumed as do ordinary incandescent lamps. The new tubular lamp is filled with a mercury vapor and a peculiar powder. Invisible ultra-violet rays are generated and these short rays are transformed into longer rays which the eye can see. The new lamps have a distinct advantage in that they remain relatively cool while in operation. This white fluorescent light is the closest approach to daylight that has ever been produced by an artificial illuminant.

The use of the Ward-Leonard control for auxiliary drives is finding a wider and wider application. In addition to four blooming mills previously reported, another one recently ordered will be equipped with Ward-Leonard control for the screwdowns, front and rear tables, and sideguards. Ward-Leonard control has been also extensively used for the various processing lines in cold strip mill departments, such as shear lines, cleaning lines, and the like.

Automatic power factor control is used on the a-c. side of the three 6000 kw. motor-generator sets furnishing power to the finishing mill drives, at Republic Steel Corporation. By automatically adjusting the excitation of the synchronous motors driving these sets in proportion to the load which these sets carry, it is possible to obtain much better voltage regulation on the high voltage system and to operate the equipment at an average power factor much closer to unity than otherwise possible. Since the power rates are apt to go up, not only with the lagging power factor but also with an excessively leading power factor, the automatic equipment just mentioned actually reduces the power bill.

Another item worthy of mention is a new type of motor driven rheostat. This rheostat uses a special geared head motor which is arranged with a flange so that it can be mounted directly to the slate panel without the use of supporting brackets. The rheostat arm is mounted directly on the low speed shaft of the motor through a mechanism which includes a slip clutch. The resistor units consist of nichrome wire wound on pyrex glass tubing and mounted directly to the rheostat studs. The use of this type of motor mounting and of a resistor which does not require wiring between the units and the studs resulted in a design which leaves the rear of the panel free of the mass of units and wiring which are present in older designs.

A new type of regulator for control of voltage, current or speed has been developed. This regulator is of the direct and quick acting rheostatic type. The moving element does not vibrate, but changes position only when there is a change in the circuit which is being regulated. The movement of the arm controls the opening or closing, in succession, of a series of silver buttons. Each silver button is mounted on the free end of an individual leaf spring of conducting material. The other end of each leaf spring is fixed and the assembly holding the fixed ends is arranged so that they are insulated from each other. The fixed ends are each connected to a tap on a fixed regulating resistance. The moving element is arranged so that at one end of the travel all the silver buttons are in contact and the regulating resistance is short circuited completely. At the other end of the travel the buttons are separated and the entire regulating resistance is in the circuit. In operation, the regulator arm finds a position which gives the desired condition. The anti-hunting feature is furnished by a damping transformer which eliminates the need for dashpots.

There is on the market a new alternating current brake which uses a torque motor as a release mechanism but instead of driving through a gear sector it is arranged to drive through a jack mechanism which gives practically straight line motion.

To meet the demand for greater rupturing capacity in a smaller space, for steel mill a-c. and d-c. auxiliary power circuits, a new line of air circuit breakers has been developed. This line of circuit breakers uses solid self-aligning main and auxiliary contacts. The arc is quenched in a special chamber. These features make it possible to secure high rupturing capacity in a small space.

An instrument designed especially for use in determining dissolved solids in boiler water, steam, and condensate so as to control the amount of blow-down and the operation of the plant to give the best quality of steam, has been developed. The instrument acts as a continuous indicator of the solids content in condensate, steam, feed or boiler water, and for checking the quantity of dissolved solids in any water containing from 1 p.p.m. to 700 grains per gallon (12,000 p.p.m. approximately).

Steam is sampled from the main steam header through small copper or monel tubing into a cooling coil and then through the stationary electrode which is connected to the main instrument. We will assume the steam in this particular plant under normal operating conditions should contain less than 4 p.p.m. of

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The trend in blooming mills is toward a mill with high roll lift and a wide bull-head pass, in order to provide slabs for strip mill use.

solids. As long as this is true, a neon light will glow. If due to lack of sufficient blowdown the steam solids approach 4 p.p.m., another light will flicker occasionally and the first will start to dim. As the solids rise the second light flickers faster until at a pre-determined point, say 8 p.p.m., it glows steadily and the first light is entirely black. By adjusting the dial so that both lights are of the same intensity the solids content of the steam can be read direct on the dial.

There has been developed a special series of electrographitic brushes possessing a ventilated structure. It is claimed that this ventilated structure enables the brush to maintain a constant arc of contact on the commutator. This ventilated or porous structure throughout the complete body of the brush allows the air pressure or vacuum, which builds up under the face of the brush, a definite avenue of escape. The ventilating holes are produced during the process of manufacture and completely honey-comb the brush.

Another feature of the ventilated type brush is that it operates much cooler than the average conventional type thus enabling the brushes to operate at higher current densities without excessive heating.

One of the important improvements made during the year of 1938 is the development of the fibre glass insulation. Test results prove conclusively that glass fibers—the kind used for magnet wire insulation—have high tensile strength. They are flexible and resistant to high temperatures. The small, continuous fibers—two ten-thousandths of an inch in diameter—are an important aid in space requirement.

However, abrasion-resistance of the untreated glass yarn is not particularly good. Moisture is a damaging influence on the unimpregnated fibers. It follows, then that the success and the advantages of glass-insulated magnet wire depend on the varnish with which the glass fibers are treated. Makers of this material have now on the market a very complete line of insulating material for use on windings for motors, generators and similar applications.

In order to learn more about what is needed and what can be expected of the various types of insulations one of the leading manufacturers of insulating cables has installed a very unique cable proving ground, now starting its second year of operation. Here, buried directly in various types of earth, pulled into conduit or installed overhead, network, control, primary distribution and portable power cables are operating under normal conditions of temperature, voltage and loading.

Cables under test are installed in four concrete troughs, each 50 ft. long x 4 ft. wide and 4 ft. deep. These troughs, open at the bottom, are each filled with a different type of soil: top soil saturated with corrosive water from a manhole; soil with a layer of manure over the cables to simulate conditions of decaying organic matter; a mixture of 99 lb. of sand and 1 lb. of lime, maintained highly alkaline; soft-coal cinders regularly wet with a sulphuric acid solution to render it positively acid. Immediately after installation each cable in each trough was tested for insulation resistance, for a-c. and d-c. capacity and power factor and a voltage test was also applied. Tests also included measurements of the physical and electrical properties of the insulation, and visual examination of the coverings. At the end of each year in the ground these field and laboratory tests are repeated.

New rubber compounds and synthetic materials have made possible improvements in all types of insulated wire and cable which will aid materially in solving the problems of insulation in industry.

Engineers in the past year have given considerable study to isolated phase, metal enclosed bus structures as compared to three phases in one housing. On one of the first major installations no expense was spared to make it perfect with the result that very few companies could afford it.

On one of the less expensive more recent developments all insulator units are in compression and all are adjustable insofar as the pressure on the bus is concerned. Insulator supports are separate castings and no strains of any kind are placed on the housings. The construction is such that the entire job may be made gas tight if desired.

It is believed the use of metal enclosed bus structures will become more general in the steel industry as the capacity of generating equipment increases.

MECHANICAL EQUIPMENT

Boiler pressures in steam generating plants have been increasing for several years but during 1938 a 2300-pound pressure installation was under construction, which is nearly double that of the so-called high pressure boilers now in use in this country.

High pressure centrifugal pumps have been largely used in connection with descaling systems of hot strip mills, because of their ability to supply a widely flexible demand and because of their low upkeep cost. On one of the latest mills three such pumps were selected, each of 1,200 gpm. capacity, providing ample pumping equipment at all times with one pump as a stand-by. Each pumping unit consists of one two-stage low pressure booster pump connected to a seven-stage high pressure centrifugal pump. Each combined unit is connected through a flexible coupling to a 1,200 hp., 1,800 rpm., 3 phase 60 cycle, 2,300 volt induction motor. The combined unit has a normal rating of 1,200 gpm. against a total head of 1,200 lb. per square inch.

A lathe is available for dressing rolls mounted in flood lubricated oil bearings or any type of bearing which, due to questions of time saving, economy and permanence of adjustment, it is desirable to leave on the roll neck while the body is redressed or turned. Rolls are placed in the machine and redressed with precision and speed not obtainable in any other equipment. The arrangement can be supplied to existing headstocks and beds and will perform with as great accuracy, as on complete new lathes.

A roll grinder has been developed for hard, heavy service. It is said to be capable of removing 5 to 6 times as many cubic inches of metal in a given time as can be done on any other grinder in existence. This machine was originally designed for plain flat work and necking, but suitable concaving and convexing equip-

ment, to grind any curve now obtainable on grinders, can be provided. This machine is particularly effective on alloys too hard to cut with machine tools. From 3½ to 7 cubic inches per minute can be removed from metal of 72 to 90 scleroscopic hardness.

MATERIAL HANDLING EQUIPMENT

Statistics show very clearly that the steel industry prefers direct current cranes, as the new cranes supplied to this industry during the year were almost without exception driven by direct current motors. The same can be said of anti-friction bearings for with possibly a few exceptions all the cranes furnished for the steel industry were completely equipped with these bearings, and spur gears are still used almost exclusively.

The span of these new cranes would indicate that the buildings now used are wider than they were some years ago for not many of these new cranes were designed to operate on spans of less than 80 feet. Attention has been called very forcibly recently to the fact that fillets must be provided on hoist shafting on important cranes if you wish to avoid serious trouble. The importance of this was not recognized when some of the older cranes were built but modern cranes are now usually designed with this important feature.

During the year two cranes were built which are a little unusual in their application. These cranes are to be used in a scarfing and chipping department, where slabs are prepared for further rolling. The building in which this work is done is served by one or more overhead traveling cranes of approximately 20-tons capacity. These large cranes handle five to six slabs at one time and pile them underneath a gantry crane runway. The gantry cranes spread out these slabs so that the workmen can get at them easily. These cranes also are used to turn the slabs over. In other words, the cranes serve the workmen on the floor in their immediate vicinity and leave the large overhead cranes for other work.

A tilting platform truck which has a rated capacity of 10,000 pounds and is of 2-wheel drive and 6-wheel steer type has been developed. The compensating trail axle has steering levers above the axle for greater road clearance and accessibility, and rods cannot drop off ball and levers. The power plant is equipped with a 500 per cent overload and high torque motor. The motor is direct connected to free coasting worm and wheel. The truck is equipped with a controller which is electrically interlocked with a mill type magnetic contactor. The angle body is locked on the platform and steady rocking action is under control of operator, dumping at any height in the range of the platform. The truck has a regenerative or ampere return lowering feature and dynamic braking for speed control on ramps.

A center-control ram tractor with a rated capacity of 15,000 pounds to 16,000 pounds has been designed to fit into the requirements of modern, wide strip mill operation. One of the principal bug bears of high-capacity ram tractor operation has been the frequency with which tire replacements must be made. In this new design, the control of the weight distribution and the design of the wide-angle steering axle are such that tractors of this type have shown no appreciable tire wear after 8 months of continuous heavy duty. Another innovation which this truck introduces is the acessibility of the various parts and units.

The power axle is of the double reduction type—spiral bevel and herringbone—and is designed to take a shock load of 40,000 pounds at 60 miles per hour, which is far above any loads which can be imposed upon it by the most severe ram tractor service. The wide-angle steering axle, which is largely responsible for the exceptional tire life, has the steering pivots, or king pins, inside the edge of the tires which imparts a rolling motion without "scrubbing" to the tire when turning. The weight of the tractor complete with power source is approximately 20,000 pounds and either battery or gasoline-electric power may be used.

A transfer and lifting dolly used for removing strip from the mandrel at the end of the rolling process has been developed. This device is said to facilitate the transfer of the material to the crane, truck or next operation in the processing of this strip material. The dolly platform is lifted vertically by means of a hydraulic lifting mechanism. A unique levelling device keeps the platform in a horizontal position regardless of where the load is placed. This equipment may be furnished with flanged wheels so that it can be transferred on the standard rails.

A new method of handling sheet steel was innovated by one manufacturer. The old method of handling them was slow and expensive and resulted in damage to the edge of the sheets. Now a package is made of the sheets weighing from four to ten thousand pounds. The package is wrapped in weather-proof paper and fastened to wooden skids by means of steel straps. The package is then handled by a lifting magnet. The magnet actually lifts most of the plates and the straps carry the balance with ease. The wooden skids prevent bending. Formerly it required three men 1½ hours to unload 20 tons of these sheets whereas now one man handles 20 tons in 30 minutes.

WELDING EQUIPMENT

As acceptance of arc welding has increased, greater attention has been paid to factors which have a bearing on its most efficient use. Thus, we find users stressing the importance of proper technique and procedures, paying greater attention to preparation, handling and positioning of work for welding, scheduling and routing of work to and from the welders, proper training of operators, importance of using welding generators of sufficient capacity, jigs and fixtures, weld cleaning tools and other miscellaneous welding accessories. Increased emphasis on welding efficiency has led to use of larger size electrodes to reduce welding costs. Advantage is also being taken of electrodes developed especially for fast production of particular type of welds such as fillets and butts.

A new electric welding process uses heat generated by the passage of electric current from an electrode to the work being welded. The end of the electrode is constantly covered by a highly resistant conductive medium supplied as a special granulated material. This granulated material is laid down along the seam to be welded and the entire welding action takes place be-

neath it without an open visible arc and without sparks, spatters, smoke or flash. Within the layer of granulated material an intense concentrated heat is generated by electric current and the bare metal electrode and a portion of the edges being welded are melted and fused. When the weld is being made a subsurface layer of this granulated material melts and floats as a liquid blanket over the molten weld metal. It also excludes the atmosphere and other gases from the metal making a clean, dense metal of excellent physical properties.

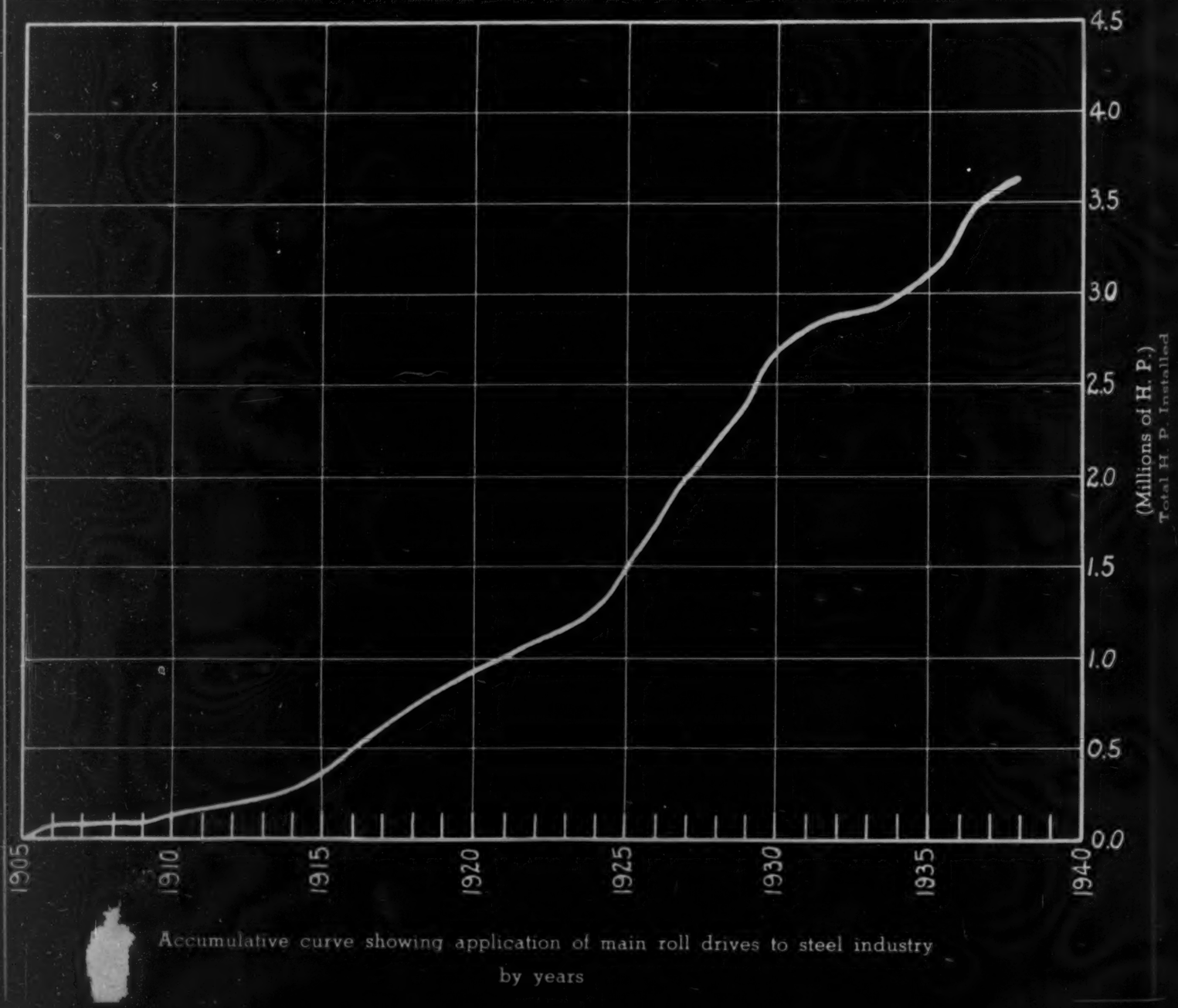
This welding process is entirely automatic, a fine wire fuse being used to start the weld. Bare rod is continuously fed from a special reel into the welding zone by the welding head. Welding voltage, current, speed and rod are all automatically regulated by the electrical controls. The welding voltage is held at a pre-determined value by the adjustable automatic voltage control which governs the rod feed. The welds have unusual strength, ductility, shock resistance, uniformity, density and corrosion resistance. Physical properties are as good or better than those of the base metal. It is not necessary for the operator to wear a shield and he works in comfort.

Butt welds require slight bevel on plate edges and can be easily made by flange cutting or planing. For fillet welds no bevel is required. No cleaning of the weld is required for the process leaves a clean smooth weld uniform in outward appearance.

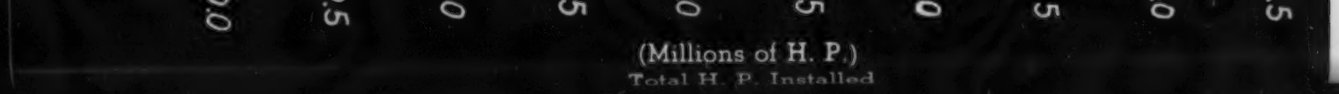
In Thermit welding the latest development is a rail weld for use on crane runway track. Right now two experimental installations are under construction. This weld is similar to the regular Thermit rail weld used in street railway work with the exception that it has been designed to eliminate the collar of weld metal underneath the rail so that welded rails may be bolted flat on the crane girders.

An interesting development of the last few months is a spot welder for fastening the inner and outer wraps of a cold reduced coil. The first unit of this type is being used on a tin plate electrolytic cleaning line in the following manner.

The coils are stripped from the collapsible tension reel and delivered to an industrial tractor. Before the



Accumulative curve showing application of main roll drives to steel industry by years



MOTORS OVER 300 HP •

APPLIED TO MAIN ROLL DRIVES IN THE IRON AND STEEL AND ALLIED INDUSTRIES DURING THE YEAR 1938

No.	Horsepower	Speed	Voltage	Frequency	Type of Mill	Purchaser	Location	Manufacturers
1	300	225/900	600	d-c	54″ Cold strip reel	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
2	300	400/1000	316	d-c	48″ Temper pass mill	Tennessee Coal, Iron & R.R. Co.	Fairfield, Ala.	Allis-Chalmers
3	300	400/1000	316	d-c	48″ Temper pass mill	Tennessee Coal, Iron & R.R. Co.	Fairfield, Ala.	Allis-Chalmers
4	400	300/1200	600	d-c	54″ 5-Stand tandem cold strip	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
5	450	375/1000	375	d-c	84″ Temper pass mill	Carnegie-Illinois Steel Corp.	Irvin, Penna.	Allis-Chalmers
6	450	375/1000	375	d-c	84″ Temper pass mill	Carnegie-Illinois Steel Corp.	Irvin, Penna.	Allis-Chalmers
7	450	375/1000	375	d-c	84″ Temper pass mill	Carnegie-Illinois Steel Corp.	Irvin, Penna.	Allis-Chalmers
8	450	375/1000	375	d-c	84″ Temper pass mill	Carnegie-Illinois Steel Corp.	Irvin, Penna.	Allis-Chalmers
9	500	500/1000	600	d-c	54″ Cold strip mill	Weirton Steel Co.	Weirton, W. Va.	Westinghouse
10	600	1178	4150	60	9″ Merchant mill	Wilber B. Driver	Newark, N. J.	Westinghouse
11	600	225/787	600	d-c	66″ Cold strip reel	Amtorg-Machinoimport	Russia	Westinghouse
12	600	225/787	600	d-c	66″ Cold strip reel	Amtorg-Machinoimport	Russia	Westinghouse
13	700	500/1000	600	d-c	32″ Cold strip mill	American Steel & Wire Co.	Cleveland, Ohio	Westinghouse
14	750	500	3300	50	66″ 3-High hot strip mill	Mitsui	Japan	General Electric
15	800	225/787	600	d-c	112″ Cold strip reel	Amtorg-Machinoimport	Russia	Westinghouse
16	800	225/787	600	d-c	112″ Cold strip reel	Amtorg-Machinoimport	Russia	Westinghouse
17	800	300/800	600	d-c	32″ Cold strip mill	Mitsui	Japan	General Electric
18	900	500	600	d-c	72″ 2-High copper breakdown	American Brass Co.	Ansonia, Conn.	General Electric
19	1000	392	440	60	Aluminum sheet mill	Aluminum Co. of America	Alcoa, Tenn.	Westinghouse
20	1000	392	440	60	Aluminum sheet mill	Aluminum Co. of America	Alcoa, Tenn.	Westinghouse
21	1000	392	440	60	Aluminum sheet mill	Aluminum Co. of America	Alcoa, Tenn.	Westinghouse
22	1000	500/800	600	d-c	44″–56″ 4-High cold strip mill	Mitsui	Japan	General Electric
23	1000	500	3300	50	66″ 4-High cold strip mill	Mitsui	Japan	General Electric
24	1500	300/600	600	d-c	54″ 5-Stand tandem cold strip mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
25	1750	175/437	600	d-c	54″ 5-Stand tandem cold strip mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
26	1750	300/600	600	d-c	54″ 5-Stand tandem cold strip mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
27	1750	300/600	600	d-c	54″ 5-Stand tandem cold strip mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
28	1750	300/600	600	d-c	54″ 5-Stand tandem cold strip mill	Youngstown Sheet & Tube Co.	Indiana Harbor, Ind.	General Electric
29	2000	100/200	700	d-c	Vertical slab edging mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
30	2500	507	6600	60	Hot strip roughing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
31	3000	150	6600	60	Tube piercing mill	Pittsburgh Steel Co.	Monessen, Penna.	General Electric
32	4000	175/350	600	d-c	Hot strip finishing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
[illegible]	4000	175/350	600	d-c	Hot strip finishing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
34	4000	50/100	700	d-c	Reversing structural mill	Weirton Steel Co.	Weirton, W. Va.	General Electric
35	4000	400	6600	60	Hot strip roughing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
36	5000	40/80	700	d-c	45″ Slabbing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse
37	5000	600	6600	60	Hot strip roughing mill	American Rolling Mill Co.	Middletown, Ohio	Westinghouse

coils are moved away from the line, the spot welder is used to tack the two outer wraps together at the end of the outer wrap of the strip. In a similar manner the two inner wraps are tacked together. This prevents the unwinding of the coil and eliminates the necessity of banding. It is further claimed that these tack welds do not interfere in any way with the rolling operation or have they found any instance where these welds have marked the mill rolls. In general, it is reported that this method of holding the coils together has been found entirely satisfactory.

It is stated on good authority that, although welding has made remarkable progress in becoming accepted as a primary process of manufacture and construction, its present use does not begin to represent the limit of its possible application. For every application where the process is used today, there are four others, economically justified, where the process is not employed. This means that the advantages of arc welded construction are being obtained in only 20 per cent of the possible applications.

CONCLUSION

The remarkable progress made by the steel industry during the past twenty-five years can be attributed in no small measure to the cooperation between the makers of equipment for the steel industry and the users of this equipment. It is gratifying to report anually the new developments which are the result of this cooperation.

The writer wishes to express his sincere appreciation to those who have in any way cooperated in the formulation of this review.

STATISTICS OF ELECTRIC MOTORS OVER THREE HUNDRED HP

SOLD FOR MAIN ROLL DRIVE SERVICE IN THE IRON AND STEEL INDUSTRY IN 1938

APPLICATION OF MOTORS TO VARIOUS TYPES OF MILLS

Type of Mill	Number	Total Motors	Total Horsepower
Hot strip mills	3	6	20,250
Cold strip mills	8	16	16,000
Slabbing mills	1	2	7,000
Copper mill	1	1	900
Aluminum mill	1	3	3,000
Temper pass mills	2	6	2,400
Structural mill, reversing	1	1	4,000
Tube piercing mill	1	1	3,000
Merchant mill	1	1	600
	19	37	57,150

Company	Location	Type of Mill	Total Motors	Total Horsepower
Aluminum Company of America	Alcoa, Tenn.	Aluminum sheet mill	3	3,000
American Brass Company	Ansonia, Conn.	72″ 2-High copper breakdown	1	900
American Steel and Wire Company	Cleveland, Ohio	32″ Cold strip mill	1	700
American Rolling Mill Company	Middletown, Ohio	Vertical slab edging	1	2,000
		45″ Slabbing mill	1	5,000
		Hot strip finishing mill	2	8,000
		Hot strip roughing mill	3	11,500
Amtorg-Machinoimport	Russia	66″ Cold strip mill	2	1,200
		112″ Cold strip mill	2	1,600
Carnegie-Illinois Steel Corporation	Irvin, Penna.	84″ Temper pass mill	4	1,800
Wilber B. Driver	Newark, N. J.	9″ Merchant mill	1	600
Mitsui	Japan	66″ 3-High hot strip	1	750
		32″ Cold strip mill	1	800
		44″–56″ 4-High cold strip	1	1,000
		66″ 4-High cold strip	1	1,000
Pittsburgh Steel Company	Monessen, Penna.	Tube piercing mill	1	3,000
Tennessee Coal, Iron and Railroad Company	Fairfield, Ala.	48″ Temper pass mill	2	600
Weirton Steel Company	Weirton, W. Va.	54″ Cold strip reel	1	300
		54″ Cold strip mill	1	500
		Reversing structural reel	1	4,000
Youngstown Sheet and Tube Company	Indiana Harbor, Ind.	54″ 5-Stand tandem cold strip mill	6	8,900
			37	57,150

TYPES OF MOTORS PURCHASED

	Total Motors	Total Horsepower
Alternating Current Motors	10	19,850
Direct Current Motors	27	37,300
	37	57,150

ELECTRICALLY OPERATED CRANE STATISTICS — 1938

TABLE NO. 1 — COMPLETE TABULATION OF CRANES, TROLLEYS AND BRIDGES PURCHASED

Number Cranes	Crane Capacity		Type of Bearings			Type of Gears				Type of Current	Number Motors	Type of Crane	Span
	Main	Aux.	Completely Anti-Friction	Partially Anti-Friction	Plain	Worm	Spur	Helical	Spur and Herring-Bone				
1	3		Yes				Yes			d-c	4	Revolving trolley	22′–0″
1	5		Yes				Yes			230–250 v. d-c	3	Standard	
1	5		Yes				Yes			d-c	3	Mill	100′–0″
2	5		Yes					Yes		440 v. d-c	6	Low type rev. soaking pit	
2	7½		Yes						Yes	230 v. d-c	3	Gantry	40′–0″
1	10			All except axles	Axles		Yes			d-c	6	Overhead traveling	85′–0″
1	10				Yes		Yes			230 v. d-c	3	Standard	
1	15		Yes				Yes			d-c	3	Mill	90′–0″
1	15		Yes				Yes			230 v. d-c	2	Trolley only	
1	15		Yes						Yes	250 v. d-c	3	Overhead traveling	90′–0″
2	15		Yes				Yes			d-c	3	Overhead traveling	80′–0″
1	15		Yes				Yes	Some		230 v. d-c	3	Standard	
2	15		Yes				Yes			d-c	3	Overhead traveling	100′–0″
1	15			All except axles	Axles		Yes			d-c	5	Overhead traveling	106′–8″
1	15		Yes			Yes				d-c	3	Mill	96′–0″
1	15			Yes			Yes			d-c	1	Bridge only	57′–0″
1	20		Yes					Yes		230 v. d-c	4	Standard	
7	20	5	Yes				Yes			d-c	4	Overhead traveling	85′–0″
1	25		Yes				Yes			d-c	5	Overhead traveling	94′–2″
1	25	10	Yes				Yes			d-c	5	Overhead traveling	94′–2″
1	30	10	Yes				Yes			230 v. d-c	4	Standard Machine Shop)	
1	30	10	Yes						Yes	250 v. d-c	4	Overhead traveling	80′–0″
1	35	10	Yes				Yes			230 v. d-c	4	Standard	
1	40	10			Sleeve		Yes			d-c	4	Mill	66′–4″
2	50	15	Yes				Yes			d-c	4	Mill	86′–4½
2	50	15	Yes				Yes			d-c	4	Mill	80′–0″
1	50	10			Yes		Yes			d-c	3	Standard trolley only	
3	60	15	Yes				Yes			d-c	4	Mill	95′–0″
2	60	15	Yes				Yes			d-c	4	Mill	85′–0″
2	60	25	Yes				Yes			d-c	4	Mill	70′–0″
1	75	15		All except axles	Axles		Yes			d-c	5	Overhead traveling	72′–6″
1	75	10	Yes				Yes			d-c	4	Ladle	50′–0″
1	90	20	Yes				Yes			230 v .d-c	4		
2	90	20	Yes				Yes			230 v. d-c	5		
1	100			Yes			Yes			230 v. d-c	2	Standard	
1	100	25	Yes				Yes			d-c	7	Ladle	82′–0″
1	225		Yes				Yes			d-c	7	Ladle	32′–0″

TABLE 2.
Types of Cranes Purchased

	Number
Overhead traveling	18
Standard	7
Mill-type	15
Gantry	2
Low-type revolving soaking pit	2
Ladle	3
Unclassified	3
Total	50

TABLE 3.
Trend of Bearing Construction

Number	Capacity (Tonnage)	Type of Bearings: Completely Anti-Friction	Partially Anti-Friction	Plain
A. Cranes				
4	5	4	—	—
2	7½	2	—	—
1	10	—	—	1
1	10	—	1 (Except Axles)	Axles
8	15	8	—	—
1	15	—	1 (Except Axles)	Axles
8	20	8	—	—
2	25	2	—	—
2	25	2	—	—
2	30	2	—	—
1	35	1	—	—
1	40	—	—	1-Sleeve
4	50	4	—	—
7	60	7	—	—
1	75	1	—	—
1	75	—	1 (Except Axles)	Axles
3	90	3	—	—
2	100	2	—	—
1	225	1	—	—
B. Trolleys				
1	3	1	—	—
1	15	1	—	—
1	50	—	—	1
C. Bridges				
1	15	—	1	—

TABLE 4.
Trend of Gearing Construction

	Number
Cranes equipped with spur gears	41
Cranes equipped with spur and herringbone gears	4
Cranes equipped with worm gears	1
Cranes equipped with helical gears	3
Cranes equipped with spur and helical gears	1
Total cranes	50
Trolleys equipped with spur gears	3
Trolleys equipped with other types of gears	0
Total trolleys	3
Bridges equipped with spur gears	1
Bridges equipped with other types of gears	0
Total bridges	1

TABLE 5.
Summation of Cranes, Trolleys, and Bridges Purchased

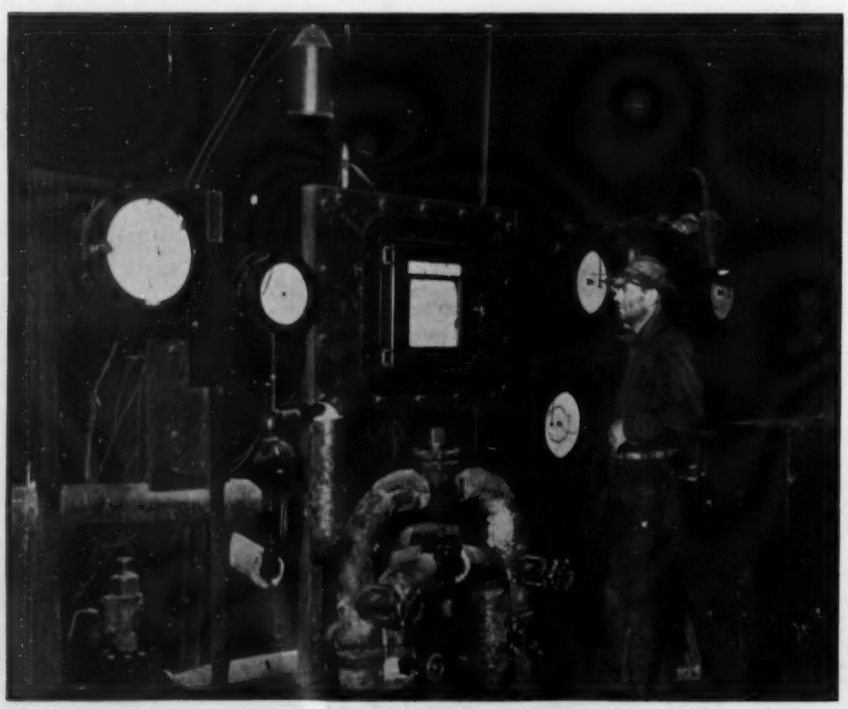
Total cranes purchased	50
Total trolleys purchased	3
Total bridges purchased	1
Cranes equipped with anti-friction bearings, completely	45
Cranes equipped with anti-friction bearings, partially	3
Cranes equipped with plain bearings	2
Trolleys equipped with anti-friction bearings, completely	2
Trolleys equipped with anti-friction bearings, partially	0
Trolleys equipped with plain bearings	1
Bridges equipped with anti-friction bearings, completely	0
Bridges equipped with anti-friction bearings, partially	1
Bridges equipped with plain bearings	0
Total tonnage of cranes, trolleys and bridges purchased	2083
Total motors purchased	143
Cranes, trolleys, and bridges using direct current	54
Cranes, trolleys, and bridges using alternating current	0

CLOSE TEMPERATURE REGULATION HELPS QUALITY AND ECONOMY

▲ A microscopically thin film of rare metal, forming the "retina" of an electric eye is now used to watch over a 150-ton batch of steel in an open hearth, as a means of keeping the temperature more uniform and producing a better quality of our most plentiful and useful metal.

Reviewing the 1938 steel research accomplishments in his Kearny, New Jersey, laboratory, Dr. John Johnston, director of research for the United States Steel Corporation, described how this development in temperature control also extends the useful life of the refractory-brick in the roof of the furnace by as much as 50 per cent.

Modern instruments and controls contribute materially to the steel making process.



The control of open hearth temperature grew out of United States Steel research to take the guesswork out of steelmaking, according to Dr. Johnston who stated that much of the research has been directed toward improved temperature control through the entire production process, and particularly in the highly important open hearth process.

The photo-electric control unit responsible for this improved quality of steel is installed in the walls of the open hearth furnace at such an angle that it "sees" only the light reflected from the roof interior. Should the inside temperature get too high and increase the brightness of the roof too much, part of the fuel supply is turned off automatically by the electric eye. Dr. Johnston believes that temperature control, although only one of the many factors in steel making that requires close control, has contributed greatly to the quality of the steel.

In addition to improved quality of steel, the "electric eye" control has brought other benefits. Longer life for the refractory brick lining is outstanding among these. Today an open-hearth furnace, as a result of automatic temperature control, may make as much as 450 or 500 heats per campaign, a 50 per cent longer useful life. Automatic temperature control also results in a higher average temperature while the furnace is in operation and thus shortens the time required to produce a heat of steel. An important phase of the temperature control work has been a standard system of instrument calibration throughout the corporation, so that uniformity is assured.

TABLE I.

TYPE 1 ROLLER—ARC WELDED DESIGN

Weights		
791 lbs. steel plates	@ 2½c. per lb.	$ 19.77
127 lbs. steel shafting	@ 3c. per lb.	3.81
Flame Cutting		
24 ft. of plates 1¼" thick	@ 8c. per ft.	1.92
Getting material and laying out plates—1½ hrs.	@ $1.30 per hr.	1.95
Forming cylindrical plates—2 pcs. per roller	@ 24c. each	.48
Machining ends of plates MK-C—1½ hrs.	@ $1.30 per hr.	1.95
Machining U-grooves in plates MK-D—1½ hrs.	@ $1.30 per hr.	1.95
Layout, drill and saw slots in shafts A and B—2 hrs.	@ $1.30 per hr.	2.60
Drilling and countersinking plates G—½ hr.	@ $1.30 per hr.	.65
Welding		
Setting up and fitting for tack welding—2 hrs.	@ $1.30 per hr.	2.60
Tack welding—½ hr.	@ $1.30 per hr.	.65
56 lbs. arc welding using ¼" dia. electrodes	@ 16½c. per lb.	9.10
Machining		
Turning roller and shafts—5 hrs.	@ $1.30 per hr.	6.50
Key seating—1½ hrs.	@ $1.30 per hr.	1.95
TOTAL COST		$ 55.88

TYPE 2 ROLLER

With forged shaft, rolled tubing cylinder and arc welded disc at each end.

413 lbs. shafting	@ 3c. per lb.	$ 12.39
4 ft. of 12" dia. tubing	@ $15.00 per ft.	60.00
Forging shaft—6 hrs.	@ $1.80 per hr.	10.80
Turning shaft preliminary to assembling and welding—4 hrs.	@ $1.30 per hr.	5.20
Arc welding 10 lbs. of —" electrodes	@ 30c.	3.00
Machining—5 hrs.	@ $1.30 per hr.	6.50
Key seating—1½ hrs.	@ $1.30 per hr.	1.95
TOTAL COST		$ 99.84

TYPE 3 ROLLER

Steel cast cylinder with steel cast ends shrunk in place.

1168 lbs. steel casting	@ 12c. per lb.	$140.16
Boring cylinder ends—6 hrs.	@ $1.30 per hr.	7.80
Turning end pieces for shrink fit—6 hrs.	@ $1.30 per hr.	7.80
Assembling ends—4 hrs.	@ $1.30 per hr.	4.20
Machining roller after assembling—8 hrs.	@ $1.30 per hr.	10.40
Key seating—1½ hrs.	@ $1.30 per hr.	1.95
TOTAL COST		$172.31

TYPE 4 ROLLER

With steel cast cylinder and continuous rolled saft.

291 lbs. rolled steel shafting	@ 3c. per lb.	$ 8.73
796 lbs. steel casting	@ 12c. per lb.	95.52
Turning shaft—3 hrs.	@ $1.30 per hr.	3.90
Boring roller—3½ hrs.	@ $1.30 per hr.	4.55
Key seating, fitting keys and forcing shaft in place—16 hrs.	@ $1.30 per hr.	20.80
TOTAL COST		$133.50

TYPE 5 ROLLER

Solid roller made of a rolled steel shaft with ends forged.

1800 lbs. rolled steel	@ 3c. per lb.	$ 54.00
Forging ends—15 hrs.	@ $1.80 per hr.	27.00
Turning —8hrs.	@ $1.30 per hr.	10.40
Key seating—1½ hrs.	@ $1.30 per hr.	1.95
TOTAL COST		$ 93.35

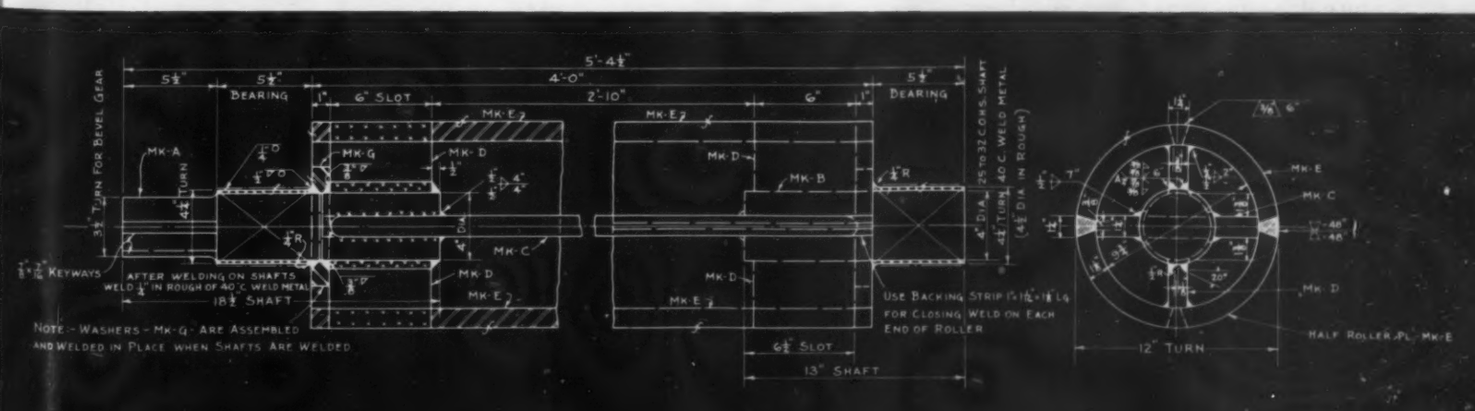
TYPE 6 ROLLER

With roller cast solid on rolled shaft with flat spots forged on shaft.

1500 lbs. steel casting	@ 10c. per lb.	$150.00
291 lbs. shafting	@ 3c. per lb.	8.73
Forging flat spots on shaft—2 hrs.	@ $1.80 per hr.	3.60
Turning roller and shaft—8 hrs.	@ $1.30 per hr.	10.40
Key seating—1½ hrs.	@ $1.30 per hr.	1.95
TOTAL COST		$174.68

Advantages of the new design are its light weight coupled with good strength qualities, low cost, and ease of repairs. It is estimated that rollers of this type would save the steel plants over $2,000,000 per year.

FIGURE 1—General arrangement of table roller of welded construction.



SQUIRREL-CAGE INDUCTION MOTORS

▲ Allis-Chalmers Manufacturing Company recently issued an illustrated bulletin on squirrel-cage induction motors, entitled: "Save on Service Costs with Low-Maintenance Motors". Several pages of this eight-page bulletin are devoted to case studies of motors that have been in operation under adverse conditions Also included are illustrated descriptions of construction details of the motors and a table giving the common types of squirrel-cage motors and their applications.

Request Bulletin No. 1195 by writing to Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

WELDED DESIGN OF MILL TABLE ROLLER

▲ The author presents a welded design for a mill table roller, (Figure 1) wherein a slotted stub shaft (mark A and B) is welded to each end of a central plate (mark C). Short ribs, mark D, are welded to the stub shafts and project into slots in the roller. Other ribs may be welded direct to plate C for large or heavy duty rollers. After welding shafts, ribs and thrust collar G in place, the half-rollers (mark E) are welded to the side edges of plate C. These half-rollers are formed from steel plate by hot die pressing. To obtain a high quality wearing surface on the shaft journals, 40-50 carbon weld material may be applied. The roller is then completed by turning the journals, a single finish turn of the roll itself, and balancing by adding weld metal as necessary.

It is estimated that there are over a quarter of a million table rollers

installed in steel mills in the United States and abroad. These are of many designs, some of which are shown in duplicate sizes in Figure 2. Estimated costs of making the rollers are shown in Table 1.

FIGURE 2—Table rollers of various construction, costs of which are given in Table 1.

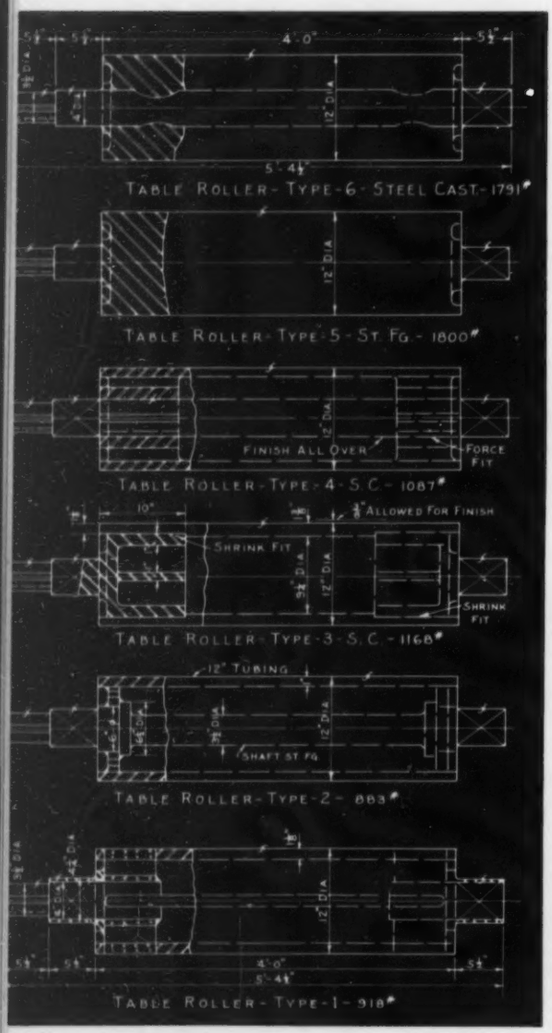


TABLE ROLLER - TYPE - 6 - STEEL CAST - 1791#
TABLE ROLLER - TYPE - 5 - ST. FG. - 1800#
FINISH ALL OVER
FORCE FIT
TABLE ROLLER - TYPE - 4 - S.C. - 1087#
ALLOWED FOR FINISH
SHRINK FIT
SHRINK FIT
TABLE ROLLER - TYPE - 3 - S.C. - 1168#
12" TUBING
SHAFT ST. FG.
TABLE ROLLER - TYPE - 2 - 883#
TABLE ROLLER - TYPE - 1 - 918#

THREE WAY BRASS LIFT PLUG VALVES

▲ A new line of three-way brass easy turn lift-plug valves has just been developed by the Homestead Valve Manufacturing Company, Inc., for use on air, water, oil, and gas services at working pressures up to 150 pounds and temperatures below 400 degrees F. The valves are available in sizes from 1¼" to 3½", and with three different styles of port arrangement. The first permits flow from either end and out the side opening, or vice versa; the second permits flow from the left hand end and out the side opening or straight through; and, the third permits flow from the right hand end and out the side opening, or straight through.

Direction of flow is changed by a quarter-turn of the operating lever. The powerful leverage permits the plug to be sealed in the body in either of its two extreme positions of travel, or in a mid-position so that all ports are closed.

DIESEL LOCOMOTIVES FOR INDUSTRIAL SERVICE

▲ The H. K. Porter Company has announced the completion and shipment of four 20-ton mechanical drive diesel locomotives to Dutch East Indies, where they will be used for general hauling and switching in a refinery.

The locomotives are of the four-wheel rod drive design, and each is powered with a Caterpillar six-cylinder diesel engine, type D13000, which develops 130 horsepower at 1000 revolutions per minute. The diesel engine is started by means of a small gasoline engine, which in turn is started by an electric starter. A dry plate clutch attached to the flywheel drives a four-speed constant mesh transmission. The output shaft of the transmission drives by means of a flexible coupling into the reverse gear unit. All gears in the transmission and reverse unit are made of alloy steel, heat treated, with machine cut teeth to insure smooth operation and long life. In the reverse unit all shafts are mounted on roller bearings and enclosed in an oil tight cast steel housing. The radiator is of the sectional type with ample cooling capacity for the tropical climate.

The main frames and bumpers are of the well-known slab steel construction, and the wheels have 2½" thick steel tires. The locomotives are equipped with air brakes, air sanding devices, electric headlights, and signal equipment. The buffers and draw gears are of special design to couple on to cars with couplers customarily used in Europe. The locomotives represent the very latest advancements both in equipment and design.

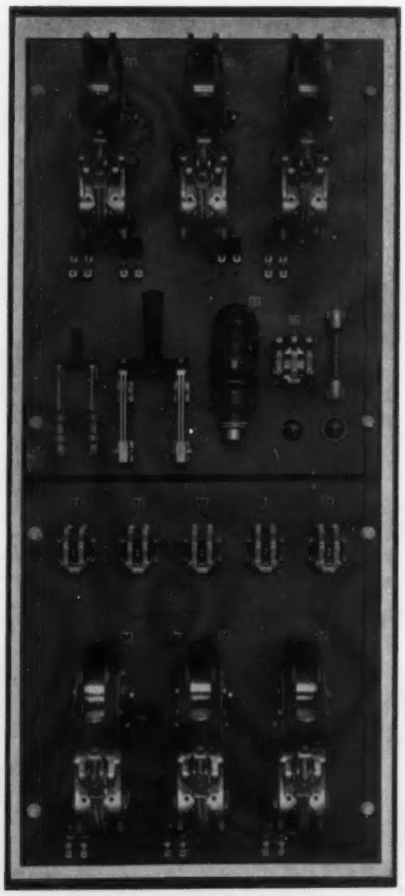
A.C.-D.C. STARTERS AND CONTROLLERS

▲ For automatically controlling the acceleration of either alternating current or direct current motors, the Electric Controller & Mfg. Company, 2682 East 79th St., Cleveland, Ohio, announce a complete new line of starters and controllers using the new "Neo-time" acceleration.

This principle is based on the time required to charge a condenser to a predetermined voltage. When this voltage is reached, the condenser discharges through an industrial type neon tube to cause the first acceleration contactor to close. When this contactor closes, the same timing circuit is re-energized to close the next accelerating contactor and this operation is repeated until the motor is operating on full line voltage.

An adjustable resistor is placed in

The new line of control equipment is particularly adapted for long acceleration periods.



the condenser-charging circuit to permit a convenient means of varying the time. This method of timing acceleration is extremely flexible since it permits a timing arrangement having practically any range of time desired. For example, a resistor permitting short maximum time may be selected or one permitting maximum time of extremely long duration may be chosen with, of course, the selection of resistors of intermediate values to provide maximum time of medium duration.

One of the important applications for this type of control equipment is in connection with drives requiring long time for acceleration. These may include fans, saws, shears with flywheels, or similar machines in which it has been necessary in the past to provide special accelerating relays in order to secure the long time required for proper acceleration of a load of these characteristics.

ADD TWO NEW TYPES OF TRANSFORMERS

▲ Two new types of weatherproof transformers for use with high intensity mercury lamps have been added to their line by the Jefferson Electric Company, Bellwood, Illinois. They are assembled in heavy one-piece drawn copper-bearing, weather-resistant steel cases filled with a high dielectric, water-proof compound of great heat conductivity. The accompanying illustrations show one of these pole type transformers with

lamp fixture mounting support and the other shows a standard indoor type. All connections in the pole type transformers may be made at the mast head adjacent to the mercury lamp, making these transformers well adapted to old installations.

NEW DEVICE CONTROLS WELDING ARC

▲ Uniformly high quality welds, particularly for applications where the expense and inconvenience of X-ray do not seem justified, are now made possible with the "Arc-Length Monitor", a new product developed by the research division of the A. O. Smith Corporation, Milwaukee, Wisconsin.

The function of this device is as follows. The welder is informed of the length of his arc by means of two tiny bulbs, mounted inside his welding helmet, one on each side of the window through which he observes the arc. Both bulbs are normally dark at the selected voltage. The one to the right glows faintly, and

Dolphs

Progress at PITTSBURGH demands progress by DOLPH

. . . . . and progress at all other cities that are associated with steel production means that DOLPH research work must be continued in order to keep in step with the latest demands of this progressive industry.

Modern developments in steel production impose a great strain on electrical equipment. Motors must operate under fluctuating loads and often at extremely high temperatures. And modern production schedules can tolerate no interruption.

We are naturally proud of the fact that many prominent steel companies have standardized on DOLPH'S Insulating Varnishes and Compounds. They have found that it pays to use DOLPH Products in their repair departments and to specify them when ordering electrical equipment.

The research facilities of the DOLPH Laboratories are at the disposal of your engineers without obligation. We invite you to consult them on any problem relative to the insulation of electrical equipment.

JOHN C. DOLPH CO.

Insulation Specialists

166A Emmett Street Newark, N. J.

with increased intensity, as the voltage increases from that selected; the one to the left responds similarly as the voltage decreases from that selected. Maximum brilliance is kept well below the point of hurting the operator's eyes or interfering with his work. The instrument itself, which contains signal lights similar to those in the welder's helmet, is placed where it can be observed by the production or welding supervisor.

This monitor will be found particularly effective where very light gauge materials are used, particularly such expensive metals as stainless steel, requiring close control of the arc. It has also proven invaluable for periodically checking the ability of experienced operators and training new operators. Experiments in the Smith welding plant show that new operators acquire ability to hold a steady arc in about one-third the usual time. It is also useful in minimizing controversy over test results in laboratories where it is desired to duplicate working conditions for welded specimens.

NEW TYPE MOTOR FOR CRANES AND HOISTS

▲ Motors designed to meet the exacting electrical and mechanical requirements of such applications as cranes, hoists, coke pushers, larry cars, turntables, steel-mill auxiliaries, bascule, lift and swing bridges, and rotary car dumpers, are described in a 4-page illustrated leaflet published by Westinghouse Electric and Manufacturing Company.

These motors are rated for intermittent service and have 275 per cent or more pull-out torque and a starting torque of approximately 90 per cent of this value. They are good for 50 per cent overspeed and plugging at full speed. Their low-inertia rotors reduce power consumption and minimize brake wear.

Sealed-sleeve bearings seal the dust, or dirt out—seal clean oil in, and maintain perfect lubrication. The motors are thoroughly insulated with taped end-turns which resist moisture, oil, dust and mild chemicals.

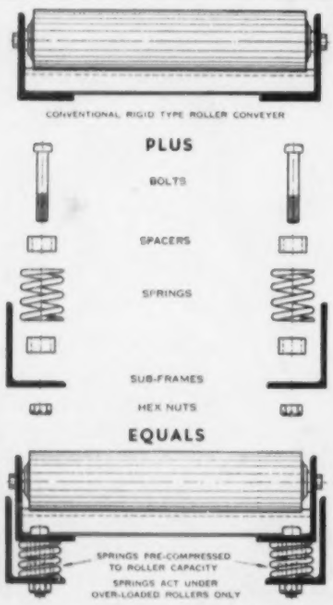
A complete line of motors with interchangeable ball or roller bearings is available. Single-row wide inner-race ball bearings, double-row bearings or roller bearings are used as determined by load conditions. An overflow sump helps prevent over greasing and makes unnecessary the previous practice of dismantling the bearings to remove old grease.

MATHEWS SPRING MOUNTED CONVEYERS

WHY. . . . . to lower maintenance costs.

WHERE . . . where the service is abusive to rollers, bearings, and axles.

WHEN . . . . for new installations or to replace old equipment.

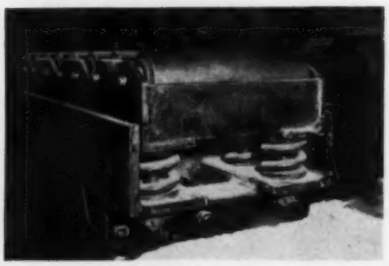


SPRING MOUNTED CONVEYER

Mathews Spring Mounted Conveyers are Protected by United States Patents No. 1,518,836; 2,077,188; 2,077,189; 2,077,190; 2,107,822 and Other Patents Pending.

CAUSE AND EFFECT

THE principle is simple; the roller axles are rigidly locked in the frame as in the conventional "rigid type" construction, but the conveyer frame which retains the rollers is carried on pre-compressed coil springs, the springs held in compression equal to the rated safe load of each roller. Under impact conditions or excessive loads the springs absorb the overload.



In pioneering this development Mathews Engineers have made available to industry nine sizes which cope with the majority of applications.

TYPE 33, Rollers 1⅝", 1.9", 2¼", 2½" diameters, 150 lbs. capacity per roller. **TYPE 53,** Rollers 2 9/16", 3½" diameters, 600 lbs. capacity per roller. **TYPE 58,** Rollers 3½" diameter, 2000 lbs. capacity per roller. **TYPE 63,** Rollers 4¼" diameter, 4000 lbs. capacity per roller. **TYPE 110,** Rollers 5" diameter, 8000 lbs. capacity per roller.

Ask for Data Sheet 24-A & B. It contains complete engineering data. The book "Equipping Industry for Continuous Production" illustrates installations. Both items sent upon request.

MATHEWS CONVEYER COMPANY
144 TENTH STREET, ELLWOOD CITY, PENNA.

CONTINUOUS FLOW PRINCIPLE OF HANDLING MATERIALS

NEW LITERATURE

▲ Pyle-National Company has released three catalogues announcing the addition of new standard conduit fittings to their line of heavy duty industrial electrical equipment. The titles of these catalogues are: Rectangular Pylets, Bulletin No. 1110; FS and FD Series Pylets, Bulletin No. 1115; and, Vaportight Lighting Fixtures, Bulletin No. 1125.

If you desire to obtain any of these booklets write to the Pyle-National Company, 1334 North Kostner Avenue, Chicago, Illinois.

▲ Morgan Engineering Company has published a profusely illustrated booklet describing ingot strippers. An outstanding improvement is the incorporation of the unit for stripping hot top ingots. An installation of a 200-ton screw-type ingot stripper is also described. This ingot stripper will strip either standard small-end-up ingots or big-end-up hot top ingots, without any change whatsoever in the mechanism. This book also shows a typical arrangement of an overhead screw-type combination ingot stripper.

Copies of this bulletin may be obtained by writing the Morgan Engineering Company, Alliance, Ohio, and requesting Bulletin No. 30-A.

▲ General Electric Company has issued a catalogue which should prove very valuable to steel mill engineers. This catalogue tells how to make portable cable joints, and gives detailed instructions for splicing and vulcanizing all the principal types of rubber-insulated, rubber jacketed portable cable. Two methods are included, the first, by the use of solder—which is considered standard. The second describes a method that is particularly well-suited to the types of cable used, where soldering is avoided whenever possible. It covers single and two conductor types of cable. The instructions on vulcanizing apply to both methods of jointing. The publication number of this booklet is GEA-2989.

In addition to this, booklets have been issued on the following subjects: automatic control panels for industrial electric heating, Bulletin GEA-594B; gear motors, Bulletin GEA-1437C; estimator for determining arc-welding electrode quantities, Bulletin GES-1749; vacuum-tube time-delay relay, Bulletin GEA-2909A; and, general purpose capacitor motors, Bulletin GEA-2915. Any of the above catalogues may be obtained by writing to the General Electric Company, Schenectady, New York.

▲ Leeds and Northrup Company offers a new 20-page, illustrated catalogue on "Micromax Condensate Purity Instruments for the Steam Plant." This booklet shows how a knowledge of condensate conditions helps to effect important operating economies. It describes a reliable electrical method for continuously determining variations in condensate purity. Illustrations include typical applications of recorders.

Leeds and Northrup Company is located at 4901 Stenton Avenue, Philadelphia, Pennsylvania. The catalogue number is N-95-163.

FURNACE ATMOSPHERES
Accurately Checked

HAYS "OT" DRAFT RECORDER

In the steel industry the HAYS Super-sensitive OT Draft Recorder is invaluable for maintaining proper atmospheres in soaking pits, annealing furnaces, open hearth furnaces, slab-mills—any place where an accurate record of Draft, Pressure or Differentials is required. Sensitive enough to register accurately increments of .0025 of an inch water pressure yet husky enough to withstand the jars and dirt of mill operation. Cut shows case for lug mounting on wall; made also for flush panel mounting and with carrying handle for spot testing. Measuring unit is the famous Hays Slack-leather Diaphragm—fool proof, long lasting. Two draft values, two pressure values, two differential values or a combination of any two of these three values may be recorded. Or a temperature recorder may be substituted for one of these values. Send for descriptive literature. Write Dept. 7-12-8.

The HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A

ITEMS OF INTEREST

W. G. Hoffman former chief engineer, sheet and tin mills is now division superintendent, tin mills, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Hoffman was first employed by the corporation in 1900 as an office boy in the general office of the former American Sheet and Tin Plate Company, Pittsburgh, Pennsylvania. He was appointed chief engineer in 1936 after service as blueprint boy, tracer, draftsman, estimator, chief estimator, assistant to chief engineer, and superintendent of construction.

John E. Angle was recently appointed division superintendent, sheet mills, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Angle has served as cold reduction foreman, metallurgist and in other capacities at the sheet and tin mills.

Fred K. Schefe former assistant chief engineer, was made chief engineer for the Gary Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Schefe was employed in 1930 at the tin mill experimental shop and worked as draftsman, foreman in the cold reduction department and assistant to resident engineer of the sheet mill until 1936 when he was appointed assistant chief engineer.

W. G. HOFFMAN

F. E. Mooney was made assistant to general superintendent, production, Gary Works, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Mooney went to Gary Works open hearth department in 1923 and during his employment there served as second helper, labor foreman, and assistant superintendent. In 1936 he was transferred to the corporation's South Works as assistant superintendent of No. 3 open hearth and bessemer. Returning to Gary in 1937 he was made superintendent of No. 2 open hearth and remained in this capacity until his present appointment.

J. N. Quinlan was made assistant division superintendent, west mills, Gary Works, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Quinlan's entire business career in the steel industry was spent at Gary Works where he started as a clerk in 1907. During his 31 years of service with the corporation he was employed as construction foreman, construction division foreman, loading checker, plant steel distributer, chief order clerk, superintendent of production, and assistant to general superintendent, process and control, the position he held until the present time.

C. A. McDowell was appointed assistant superintendent of bar mills at Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. McDowell began his service in the steel industry as a roll turner apprentice in 1907 at the Newburgh Works of the American Steel and Wire Company. After four years he was made roll designer and turner, a position he held until 1914. Leaving the corporation at this time, he was employed with various companies as assistant roll designer, assistant superintendent, and general superintendent of rolling mills. He goes to the Gary Works from the Pittsburgh Steel Company where he has been superintendent of rolling mills since 1936.

George J. Parker has been appointed assistant to district industrial engineer, Chicago district, Carnegie-Illinois Steel Corporation. Mr. Parker began his service with the corporation in April, 1936, at the Gary Works. He was employed in the industrial engineering division and remained there until his present appointment. He has been in this type of work since 1927 but with companies not affiliated with the United States Steel Corporation.

James L. Mauthe general superintendent of the Youngstown district plants of the Youngstown Sheet and Tube Company Youngstown, Ohio, has been appointed a trustee of Pennsylvania State College. Mr. Mauthe was graduated from Pennsylvania State College in 1913. He entered the iron and steel industry in the blast furnace department of the former Carnegie Steel Company at Duquesne, Pennsylvania, later serving with National Tube Company at McKeesport, Midvale Steel Company at Coatesville, the former Illinois Steel Company at Gary, and the National Tube Company at Lorain. In May, 1935 he became general superintendent of

J. L. MAUTHE

the Youngstown Sheet and Tube Company, which post he held until named general superintendent of the company's plants in the Youngstown district.

Earl M. Richards
assistant to the vice-president in charge of operations, Republic Steel Corporation, since 1935, has been named assistant vice-president in charge of operations. Mr. Richards will continue in charge of the operations of the corporation's subsidiaries. A graduate of Bucknell University in 1913, Mr. Richards was first associated with the Westinghouse Air Brake Company as assistant to the chief engineer and assistant to the manager of engineering, remaining there until 1919. From 1920 to 1925 he acted as consulting electrical and mechanical engineer, and in 1925 was made chief industrial engineer of the Jones and Laughlin Steel Corporation, Aliquippa Works. In 1930 he was appointed chief industrial engineer of the Republic Steel Corporation and subsidiaries.

EARL M. RICHARDS

Mr. Richards is a member of the Association of Iron and Steel Engineers, American Iron and Steel Institute, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Management Association, Engineers Society of Western Pennsylvania, and is a trustee of Bucknell University.

An event unique in the industrial history of Worcester, Massachusetts, was held recently, when the employes of the Morgan Construction Company tendered a banquet to the directors of the company. This affair was also significant because it marked the fiftieth anniversary of the first Morgan continuous rolling mill built for the steel trade by Charles H. Morgan, founder of the concern.

The plans for the banquet sprang spontaneously from the employes and were not made known to the directors until all arrangements for the celebration had been completed. The employes stated that the fiftieth anniversary of the first Morgan continuous rolling mill seemed a suitable occasion for them to express their esteem for the directors. As a token of their regard they presented a hand-printed scroll to Paul B. Morgan, son of the founder and president of the firm.

Speaking of the growth of the Morgan Construction Company over the past fifty years, Paul B. Morgan, president, said:

"None of these attainments could have been possible without wholehearted cooperation between the employes and management. This cooperation has been fostered from the very inception of the company and has borne fruit in the world-wide reputation which the concern enjoys".

J. E. N. Hume
who has been manager of the industrial department of the General Electric Company since 1935, was made a commercial vice-president at Schenectady, New York. Mr. Hume, after graduation from the University of Virginia, entered the company's test course and upon completion saw service in the switchgear and lighting departments in its Baltimore office. Entering the industrial department in 1912, then known as the power and mining department, he was made manager of the motor division in 1928, and the following year assistant manager of the department.

J. E. N. HUME

A. S. Moody
was made a commercial vice-president of the General Electric Company, Schenectady, New York. Mr. Moody

Employees of the Morgan Construction Company commemorate the fiftieth anniversary of the first Morgan continuous rolling mill, by playing host to directors of the company at a banquet.

has been manager of the northwest district of the company since 1936, prior to which he was manager of the northwestern territory. He was graduated from the University of California in 1906 and started work as a salesman in the San Francisco office of the Stanley G. I. Company the same year. In 1907 he went with the supply department of General Electric Company at its San Francisco office and the following year transferred to Seattle. In 1910 he was made manager of the supply department at the Portland, Oregon, office, and in 1913 became assistant manager there. In 1923 he was appointed manager of the Los Angeles office and in 1924 manager of the Northwestern territory.

E. W. Seeger

was appointed chief engineer of Cutler-Hammer, Inc., Milwaukee, Wisconsin. Mr. Seeger became associated with Cutler-Hammer in 1913,

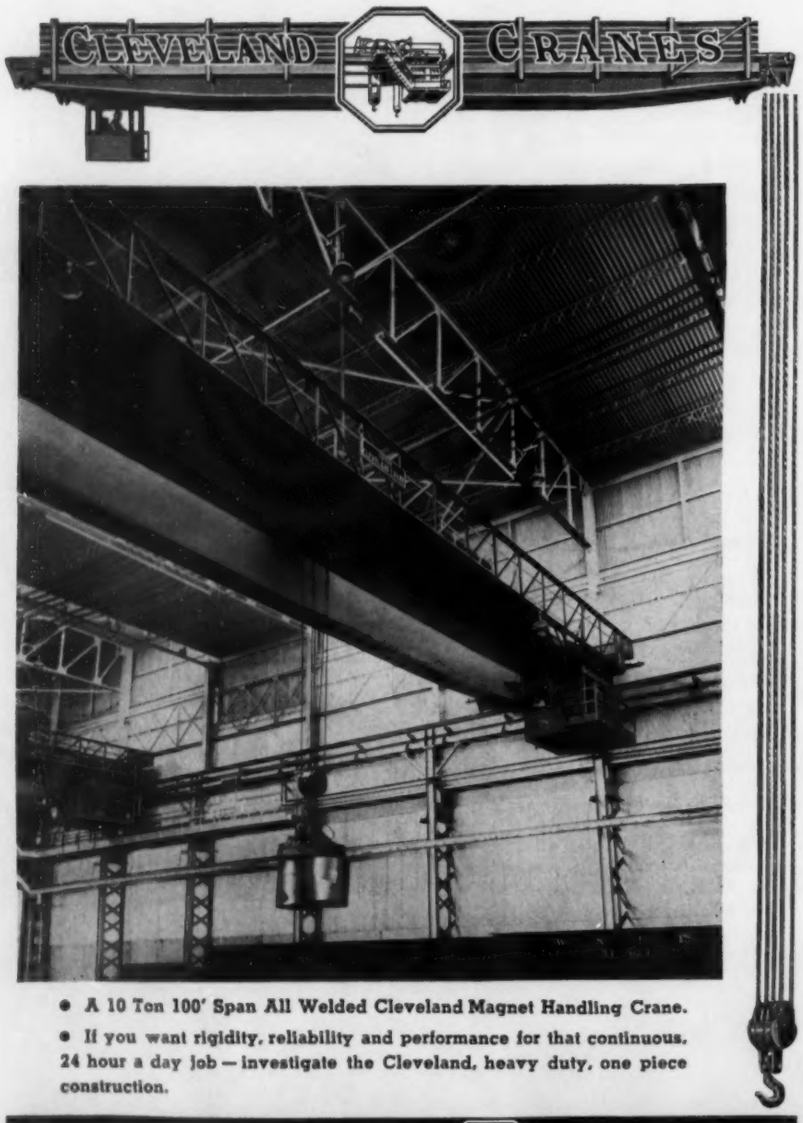
E. W. SEEGER

shortly after receiving a degree from Ohio State University. During the ensuing fifteen years he had considerable experience in shop and engineering departments, becoming assistant chief engineer in 1928, a position which he has held until the present promotion.

P. B. Harwood

was recently made assistant chief engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin. Mr. Harwood, after graduating from Carnegie-Institute of Technology, was employed by Cutler-Hammer, entering the company's training course in 1917. He was shortly transferred to the engineering department where he spent several years as a designing engineer. In 1923 he was made supervisor of

P. B. HARWOOD



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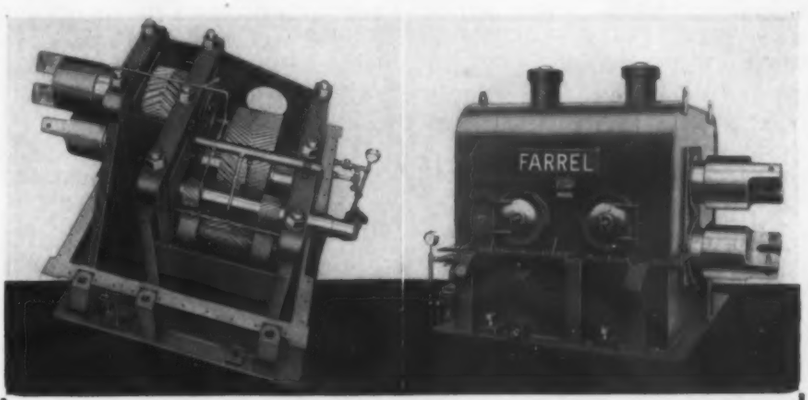
the steel mill control division, and in 1928 was promoted to general supervisor of the engineering department. From 1934 to 1936 he was assigned to the development of propulsion control for submarines.

W. S. Edsall formerly sales manager, has been appointed assistant manager of the electrical department, in charge of switchgear sales and engineering division of the Condit Works of the Allis-Chalmers Manufacturing Company, Boston, Massachusetts. Mr. Edsall, who succeeds George A. Burnham, resigned, entered the United States Navy in 1917 as a switchgear specialist. He was assigned to experimental work on submarine detection at New London, Connecticut. Later he spent some time at the United States Naval Academy and was then assigned to the submarine service until the end of the World War, at which time he was employed by the Sperry Gyroscope Company.

In 1920 he entered the employ of the Condit Electric Manufacturing Company of Boston, Massachusetts, and was made sales manager in 1922. In 1928 he was appointed general sales manager of the American Brown-Boveri Company and also a director of Condit Electric Manufacturing Corporation. When Allis-Chalmers Manufacturing Company purchased these companies in 1931, Mr. Edsall continued his connection with them as manager of sales for the Condit Works and later for the switchgear division with headquarters at the Condit Works.

W. S. EDSALL

W. W. Sebald vice-president and assistant general manager of the American Rolling Mill Company, Middletown, Ohio, has been elected a director of the company. He fills the vacancy on the board of directors caused by the death of J. H. Frantz. Mr. Sebald left high school in the junior year to go to work. He worked for a short time in a bank, and in 1906 was employed by the American Rolling Mill Company as an office boy. After a few years, he entered the sales department, becoming Armco's only traveling salesman at that time. After service in the United States Navy during the World War, Mr. Sebald resumed his duties as manager of the American Rolling Mill Company's New York office. In 1919 he was recalled to the headquarters at Middle-



WELDING SOLVES PROBLEMS of DELIVERY and DESIGN

A short delivery was required on six of these drives and no patterns available for the case. The difficulty was overcome by welding the cases of rolled plate, with steel castings for the bearing chocks and caps and foundation bolt columns.

Welding also permitted location of light and heavy sections as required without the limitations that an abrupt change of section imposes on cast structures.

The two views of the drive above illustrate the relatively simple design of the interior for mounting the gears and bearings and the rounded contours possible in a fabricated structure.

Other features of these Drives are the integral pinion unit for direct connection to the mill, the Farrel-Sykes continuous tooth herringbone gears and mill pinions and anti-friction roller bearings. The gears are lubricated by built-in sprays and the bearings are flood lubricated, oil being supplied to both gears and bearings by a central lubricating system. The breathers mounted on the cover prevent oil contamination by trapping dirt and moisture.

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town, Ohio, to become assistant general manager of sales. His next advancement came in January, 1923, when he was made assistant vice-president. On July 15, 1926 he was again promoted, this time to the position of vice-president in charge of commercial activities. During the summer of 1938, he was advanced to the position of vice-president and assistant general manager.

Edward I. Evans
formerly general superintendent of the Gulfsteel District, Republic Steel Corporation, Gadsden, Alabama, has been named manager of the Gulfsteel District. Mr. Evans was transferred from Buffalo, where he was assistant district manager for Republic, to the position of general superintendent of the Gulfsteel District late in 1937. He was born in Glasgow, Scotland, in 1887 and started his steel career in that city at the age of 12. He came to the United States in 1907 and became associated with the Worth Steel Company, Coatesville, Pennsylvania, working in the open hearth department. In 1916 he joined the United States Steel Corporation at its Duluth plant and in 1916 returned to the Worth Steel Company as assistant bolt and nut superintendent. Two years later, when Midland Steel removed its plant to Claymont, Delaware, he was made open hearth superintendent. In 1929 he joined Bourne-Fuller Company, Cleveland, Ohio, as general manager, and three years later was made assistant manager of the Central District for Republic Steel Corporation. His next move was to Buffalo in 1934.

C. L. Bransford
formerly general superintendent of the Birmingham District, Republican Steel Corporation, Birmingham, Alabama, has been named manager of that district. Mr. Bransford, who was graduated from the University of North Carolina, specialized in chemical engineering, and joined the Tennessee Coal, Iron and Railroad Company as chemist. He was later made superintendent of the Alice furnace plant in Birmingham. In 1915 he left to go with Gulf States Steel Company as superintendent of the blast furnace department and four years later became superintendent of blast furnaces for the Woodward Iron Company. In 1921 Mr. Bransford went with Semet Solvay Company as fuel engineer and later was made general manager of that company's Ashland, Kentucky, plant. From there he was transferred to Buffalo, New York, as superintendent of the company's plant in that city. In 1929 he returned to Birmingham as superintendent of blast furnaces and coke ovens for the former Republic Iron and Steel Company.

Wade H. Oldham
has resigned from the position of manager of the southern district, Republic Steel Corporation, Birmingham, Alabama. Because of the recent division of the Republic Steel Corporation's southern operations into the Birmingham and Gulfsteel Districts, Mr. Oldham's position will not be filled.

A. G Delany
formerly superintendent of maintenance, Gulfsteel Division, Republic Steel Corporation, has been named assistant district manager. Mr. Delany was born in Evanston, Illinois, and studied mechanical engineering at the Georgia School of Technology and hydraulic engineering at Ohio State University. He was construction engineer and superintendent of construction for eight years with Dwight P. Robinson Company, working in both the United States and South America. He was also employed for eight years with the Gulf States Steel Company as construction engineer and superintendent of maintenance, retaining that position following the merger of Gulf States Steel with the Republic Steel Corporation.

W. M. Farnsworth
formerly superintendent of the electric furnace department of Republic Steel Corporation, has been named general superintendent of the company's Canton plant, succeeding Byron R. Richardson, who recently died. Mr. Farnsworth was born in Nashville, Tennessee, and received his education in the public schools of that city. He entered the employ of the United States Steel Corporation at South Chicago, Illinois, in 1914, and went to Canton, Ohio, in 1919, where he worked until 1925 as melter in the electric furnace department of the Timken Roller Bearing Company. In 1925 he joined the United Alloy Steel Corporation as superintendent of electric furnace department and retained this position through the mergers which finally brought that company into the Republic Steel Corporation.

J. H. Kennedy
has been appointed superintendent of the electric furnace department, Republic Steel Corporation, Canton, Ohio, succeeding W. M. Farnsworth. Mr. Kennedy has been with Republic and its antecedent companies since 1916, when he entered the employ of United Alloy Steel Corporation electric furnace department. At the outbreak of the World War, he joined the marines and returned to United Alloy in 1919, advancing to the position of melter in 1925. He was born in Canton, Ohio, and educated in the public schools of that city.

Paul L. Walter
superintendent of power in the Canton plant of the Republic Steel Corporation, has been named superintendent of the mechanical department. Mr. Walter is a graduate of the Canton Public schools and of Purdue University in 1912. After graduating from college he joined Pickands, Mather and Company as a civil engineer during the construction of the coke ovens and blast furnaces at the United Furnace Company plant, Canton, Ohio. He entered the army in 1918 where he received a commission as a second lieutenant. After the World War he returned to the United Furnace Company, as efficiency engineer, and in 1921 he became chief engineer in charge of the power plant. When United Furnace merged with United Alloy Steel Corporation, he became assistant superintendent of power and in 1922 was promoted to superintendent of power, retaining that position with Republic Steel Corporation until his recent appointment as superintendent of the mechanical department.

G. H. Davis
was named master mechanic, heading the mechanical department for the Gulfsteel Division of the Republic Steel Corporation, Gadsden, Alabama.

I. Lamont Hughes formerly executive vice-president of the Carnegie-Illinois Steel Corporation, has been appointed Secretary of Highways, in the cabinet of the State of Pennsylvania. Mr. Hughes was born in Mercer, Pennsylvania, January 25, 1878. He received his early education in the public schools of Mercer and New Castle, later attending the high school at North Braddock, Pennsylvania. Immediately after graduating from high school, Mr. Hughes entered the employ of the Edgar Thomson Works of the Carnegie Steel Company. He was put to work in the engineering corps, spending part of his time in the drafting room and part in the mill with the rod and chain. In 1901 he was appointed head draftsman and assistant master mechanic of the Union Steel Company, Donora, Pennsylvania. He remained there for four years and returned to the Carnegie Steel Company, receiving an appointment as master mechanic of the bar mills at Youngstown, Ohio. This position included the upper and lower mills in Youngstown, and the mills at Warren and Girard, Ohio, and at Greenville, Pennsylvania. In 1906, Mr. Hughes was made assistant general superintendent of the bar mills of the Youngstown district, and five years later he became general superintendent of these mills continuing in that capacity for five more years. In January 1916 he was made assistant general superintendent of the entire Youngstown district of the Carnegie Steel Company, whose operations at that time included construction of the modern steel bar mills at McDonald, Ohio.

Mr. Hughes went to Canada, June, 1916, as general superintendent of the Canadian Steel Company's project in the Province of Ontario. Two years later, in June 1918, he returned to the United States as general superintendent of the operations carried on by the United States Steel Corporation for the federal government at Neville Island, Pittsburgh, Pennsylvania. In May 1919 he was made president of the Lorain Steel Company, Johnstown, Pennsylvania holding this position until January, 1920, when he was made general superintendent of all the operations of the Carnegie Steel Company in the Youngstown district. He remained there until January, 1925, when he was elected a vice-president of the Carnegie Steel Company. In 1928 he was made vice-president in charge of operations for the United States Steel Corporation, with headquarters in New York, New York. Mr. Hughes was elected president of the Carnegie-Steel Company on September 1, 1930, and when the Carnegie-Illinois Steel Corporation was formed he was made executive vice-president and director of the new combine. He held this position until his resignation in April, 1936.

H. LAMONT HUGHES

E. A. Brown, Jr. has been made superintendent of the fuel department of the Carnegie-Illinois Steel Corporation, Gary Works, succeeding Vaclav Gregor who was recently made assistant superintendent of steel production.

Mr. Brown began his service with the corporation in 1911 as a tracer and detailer at its Homestead works where he remained until 1937. During this time, he served in the experimental engineering department and as turn foreman, special engineer, and assistant to mechanical engineer in charge of steam and power. In August, 1937, he was transferred to the corporation's Duquesne works as assistant to general superintendent and has been employed in this capacity until coming to Gary works at this time.

A. C. Dyer effective March 1st, will be the general sales manager of the Electric Controller and Manufacturing Company with headquarters in Cleveland, Ohio. Mr. Dyer was graduated from Carnegie Institute of Technology in 1911. He was employed, following his college career, in the electrical department of the West Penn Steel Company, now the Allegheny-Ludlum Steel Company, as well as the Homestead Works of the Carnegie Steel Company, now the Carnegie-Illinois Steel Corporation. Since 1913 Mr. Dyer has been in the Pittsburgh office of the Electric Controller and Manufacturing Company and has functioned as the district manager since 1916. Mr. Dyer has been a prominent associate member of the Association of Iron and Steel Engineers for over twenty years, acting on various Pittsburgh committees and taking a deep interest in the affairs of the Society. **R. G. Widdows** who has been both vice-president and general sales manager, will now devote most of his time to executive duties. Mr. Widdows attended the University of Pennsylvania and has been associated with the Electric Controller and Manufacturing Company for the past twenty-nine years. He was district manager of the New York office and in 1924 was brought to Cleveland as sales manager. In 1925 Mr. Widdows was elected vice-president of the company in addition to his sales manager position.

A. C. DYER

Z. W. Whitehouse has been made superintendent of the electrical department, Republic Steel Corporation, Canton, Ohio. Mr. Whitehouse was born in England and came to the United States with his parents when he was a small child. He attended the Canton public schools and the Y. M. C. A. night schools and took his first job as machinist apprentice with the United Electric Company, Canton. He was later employed by the Dillon Electric Company, and in 1915 became electric shop foreman with United Steel Company. He later served as electrical foreman South Division, Blast Furnace Division, and Canton Steel Division, at Republic.

Lee B. Landon former assistant general superintendent, tin mills, Carnegie-Illinois Steel Corporation, Gary, Indiana, was appointed superintendent of the corporation's American Works at Elwood, Indiana. Mr. Landon was first employed at the American Works as a draftsman in 1901. His experience in the steel industry has included the following positions: master mechanic construction engineer, assistant manager of American Works, and assistant manager and manager, Gary tin mill. He has been assistant general superintendent since July, 1936.

John J. Golden was appointed superintendent of steel production at the Gary Works of the Carnegie-Illinois Steel Corporation, Gary, Indiana, succeeding A. W. Slater, resigned. Mr. Golden comes to the Gary Works from the corporation's South Chicago plant where he began in 1911 as an office boy. He served as a relief foreman, stock foreman, general relining foreman, and assistant superintendent of various open hearths. On October 1, 1935 he was advanced to the superintendency of the No. 2 open hearth at South Works and remained in that capacity until his present appointment.

A. V. Martin was appointed superintendent of steel provision, west mills, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Martin's entire career in the steel industry has been with subsidiaries of the United States Steel Corporation at Gary, Indiana. He was employed in 1915 by the American Sheet and Tin Plate Company and later served as load checker and finishing end foreman of the Gary Works merchant mills until 1918 when he was transferred to the general superintendent's office. He became general office assistant in January, 1938, and remained in that position until his present appointment.

James M. Woodward, Jr. has been appointed superintendent of bar mills at Gary Works of the Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Woodward began his service with Carnegie-Illinois Steel Corporation, December 1, 1937, as superintendent of steel provision at Gary Works merchant mills and was employed in this capacity until his present appointment. His experience in the steel industry prior to his association with Gary Works included the following positions: inspector of rails, merchant bars, and other steel products, chief inspector, engineer in charge of metallurgical laboratory, strip mill recorder and general foreman of four-high hot strip mill. Mr. Woodward has been associated with several steel mills, the last being Great Lakes Steel Corporation, where he began as a strip mill recorder, later becoming general foreman of that company's four-high hot strip mill.

Ben Huff former acting superintendent at the Carnegie-Illinois Steel Corporation's American works at Elwood, Indiana, has been named assistant to chief engineer, sheet and tin mills. Mr. Huff has been connected with the steel industry since 1901 and served with several United States Steel Corporation subsidiaries as machinist, shop foreman, assistant master mechanic, and master mechanic.

E. G. Hill has been appointed assistant to general superintendent in charge of technological coordination, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Hill started his business experience in 1913, when he was employed by various mining and construction companies as miner, assistant mill superintendent, and mill superintendent until 1918, when he became an instructor of mining engineering at the Carnegie Institute of Technology. Two years later, he went to the University of Pittsburgh as associate professor of metallurgy, and remained there until 1931, when he became engaged in research work at the Mellon Institute. Since 1934 he has been director of research at the Lukens Steel Company in Coatesville, Pennsylvania.

J. Frank Frain has been appointed assistant superintendent, merchant bar mills, Carnegie-Illinois Steel Corporation, Gary, Indiana. Mr. Frain began work with the corporation as a foreman for the National Tube Company at Ellwood City, Pennsylvania, in 1922. A year later he was transferred to the Tube company's Gary plant as assistant superintendent of the pipe mill and remained in this capacity until 1929. Leaving the corporation, he spent four years as assistant plant manager of the Lyon Metal Products Company, Aurora, Illinois, until his return to the Gary Works merchant mills. In 1934 he again left the corporation to be general superintendent of the Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania, and remained with them until his return to the Gary Works at this time.

Harry F. Knapp was appointed as manager of sales, special accounts, for Carnegie-Illinois Steel Corporation, with headquarters at Washington, D. C. Mr. Knapp has been associated with the subsidiary of United States Steel Corporation since 1903, when he joined the organization at its Philadelphia sales office. He went to Washington in 1915, and in 1926 was appointed assistant manager of sales of the Washington district sales office. He has been manager of sales there since 1931.

Andrew J. Snow was made manager of sales of the Washington, D. C. office of the Carnegie-Illinois Steel Corporation. Mr. Snow has spent his entire business career with the company since leaving the Carnegie Institute of Technology in 1912. He served in various capacities at the mills, in the general offices,

(*Please turn to page 98*)

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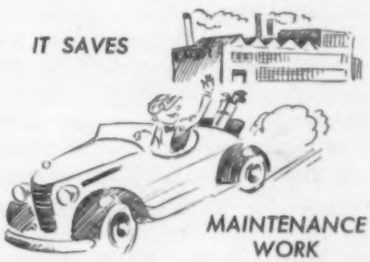

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and since 1932 has been assistant manager of the Washington district sales office.

Kinley D. Tracy has been appointed assistant sales manager of the Baker Industrial Truck Division, Baker-Raulang Company. Mr. Tracy has been associated with this company for the past five years and has been in charge of advertising and sales promotion. This change in his status results from a gradual enlargement of his duties. Mr. Tracy is a graduate of the School of Mechanical Engineering, University of Purdue, where he received his M. E. degree.

Mr. Tracy will maintain his headquarters at the Baker-Raulang Company, 2168 West 25th Street, Cleveland, Ohio.

Joseph Becker vice-president and a director of Koppers Company, has been made president of Koppers - Rheolaveur Company. Mr. Becker is also general manager of Koppers Company's engineering and construction division. He has been with the company since its beginning and has been an official since 1920. He is the inventor of the Koppers Becker type of coke oven and of processes for the recovery of derivatives in the manufacture of gas and coke.

W. S. McAleer manager of Koppers-Rheolaveur, has been made a vice-president and a director of that company. Mr. McAleer joined the former Koppers Construction Company, now the engineering and construction division of Koppers Company, as an engineer in 1926. In 1930 he joined the sales department, and in July, 1938, he was made manager of Koppers-Rheolaveur Company.

Charles Fassinger, Sr. has resigned as vice president of the Oliver Iron and Steel Corporation, Pittsburgh, Pennsylvania. He started with the corporation in 1895, working up through the manufacturing departments to the general managership of the plant, and early this year was elected vice-president in charge of development and research.

R. M. Alvord formerly manager of General Electric Company's Pacific district, was appointed a commercial vice-president at Schenectady, New York. Mr. Alvord was graduated from Iowa State College in 1904, and immediately entered the General Electric test course at Schenectady, and in 1906 was transferred to San Francisco, California, as a salesman. He became manager of the supply department there, then manager of the San Francisco district office, and in 1936 manager of the newly-created Pacific district of that company.

C. R. Fletcher was named mechanical general foreman, for the Gulfsteel Division of the Republic Steel Corporation, Gadsden, Alabama.

George A. Burnham has resigned as assistant manager of the electrical department, in charge of switchgear sales and engineering division of the Condit Works of the Allis-Chalmers Manufacturing Company, Boston, Massachusetts. Mr. Burnham is being relieved of his duties at his own request as he is anxious to devote more time to personal matters and to travel. In the future he will be retained by Allis-Chalmers in a consulting capacity.

Lorin L. Ferrall metallurgist with Timken Roller Bearing Company, Canton, Ohio, has resigned that position to become affiliated with the Rotary Electric Steel Company, Detroit, Michigan.

Obituaries

Fred C. Dustman superintendent of the tube mill, Youngstown Sheet and Tube Company, Youngstown, Ohio, died recently in his forty-seventh year. Mr. Dustman, who also is secretary and a director of the Federal Iron Works, was a native of Youngstown, Ohio. He had been associated with the Sheet and Tube company for thirty years.

William Robbins Seigle chairman of the board of directors, vice-president and director of research of Johns-Manville Corporation, died recently in his fifty-ninth year. Mr. Seigle, associated with Johns-Manville for nearly forty years, served in many varied capacities. He became vice-president in charge of factories and mines in 1917, and became chairman of the board of directors in 1929. At the time of his death he was, in addition to his position with Johns-Manville, president of the Asbestos Wood Company and a director of the Asbestos and Danville Railway.

George W. Jahn assistant to chief engineer, sheet and tin division, Carnegie-Illinois Steel Corporation, Gary, Indiana, died in his sixty-fourth year. Mr. Jahn had been with the corporation since 1904 when he started as a line foreman in the electrical department at South Works. In 1910 he was transferred to the sheet and tin mills where he served as master mechanic, resident engineer and assistant to chief engineer, the position he held at the time of his death.

Percy C. Day vice-president and chief engineer of the Falk Corporation, Milwaukee, Wisconsin, died recently in his sixty-third year. Mr. Day was graduated from Central Technical College, South Kensington, England. After doing work in the electric-metallurgical field, he came to the United States and became associated with the Falk Corporation in 1910. His work with the Falk Corporation as chief engineer consisted of pioneering in the design of helical and herringbone gearing. In 1937 he was named vice-president of that company.

Byron R. Richardson superintendent, steel division, Republic Steel Corporation, Canton, Ohio, died recently in his forty-first year. Mr. Richardson began his steel career with the United States Steel Corporation at Gary, Indiana. Before going to the Republic Steel Corporation, he was associated with a New Castle, Pennsylvania, rolling mill, and the Empire Steel Corporation, Mansfield, Ohio. Mr. Richardson worked at the Canton Works for fifteen years.